

Ambidexterity and management control packages

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SUMMARY

Ambidexterity concerns the capability to combine exploration and exploitation. Exploration means the development or search for new competencies and capabilities. Exploitation means applying or leveraging existing competences and capabilities. Ambidexterity gets much attention considering its association with organizational performance. Projects are one specific setting where ambidexterity can be required when project teams need to handle unique challenges while facing tight constraints. This dissertation consists of three articles regarding ambidexterity in projects.

Despite the vast amount of studies that proof the performance effects of ambidexterity, ambidexterity research still lacks empirical studies that clarify how exploration and exploitation are united in practice. The first and second study address this question. Both studies rely on case study evidence from the same project in one of the leading multinational chemical companies. The objective was to perform a holistic and in-depth investigation of one successful project. Data was collected through observation, interviews, meetings and analysis of procedure manuals. Another loose end in ambidexterity literature concerns the impact of ambidexterity on workers' well-being. The third study relies on survey data (n=183) to examine if an individual project worker who needs to combine exploration and exploitation in his daily project work experiences a higher job fatigue.

The first study illustrates how the four antecedents of ambidexterity can explain project ambidexterity. We describe how a project team in a chemical firm successfully achieved project ambidexterity in a turnaround project at the occasion of a plant shutdown. Hereby (1) all four antecedents of ambidexterity could be observed (i.e., structural, sequential, contextual and leadership-based antecedents). Furthermore, (2) no inconsistencies and (3) some complementarities between the antecedents of ambidexterity were observed. The case study findings clearly demonstrate that it is possible to explain project ambidexterity by considering a combination of the four different antecedents of ambidexterity. A limited focus that does not consider all antecedents of ambidexterity across the different levels of analysis, could overestimate the effect of the considered antecedents of ambidexterity while the observed antecedents only partially explain by the pretended relation. Further research is necessary to investigate to which extent the demonstrated usefulness of this approach can be generalized.

The second study examines how the management control package fostered exploration and exploitation during the project case. The results demonstrate that a hybrid control package, combining diverse control practices, facilitated to foster both exploration and exploitation simultaneously. Additionally, we describe how combinations of controls were used to foster exploration and/or exploitation, whereby the emphasis on specific controls as well as on their influence on exploration and/or exploitation varied during the different project phases. No

incompatible needs for exploration and exploitation were noticed when they were combined which substantiated the orthogonal ambidexterity view. Furthermore, we found that the hybrid control package stimulated single as well as double learning. This learning in turn stimulated timely adaptation of the control package to changes in the complex dynamic environment.

The survey data in the third study demonstrated that an individual project worker who needs to combine exploration and exploitation in his daily project work does experience a higher job fatigue. Furthermore, the results show that Karasek's demand-control-support model explains job fatigue, similar to previous research. We found that job fatigue is associated with higher job demands, lower levels of job control and lower levels of job social support. The amount of variance explained by Karasek's demand-control-support model was much larger than the amount of variance explained by ambidexterity. We also found a positive interaction effect between ambidexterity and job control. Ambidexterity weakens the reduction effect of job control on job fatigue, in line with expectations.

SAMENVATTING

Ambidexteriteit betreft de bekwaamheid om exploratie en exploitatie te combineren. Exploratie betekent het ontwikkelen of zoeken naar nieuwe kennis en vaardigheden. Exploitatie betekent het hergebruiken en verfijnen van bestaande kennis en vaardigheden. Ambidexteriteit krijgt veel aandacht omdat het gerelateerd is aan bedrijfsprestaties. Projecten zijn een specifieke setting waar ambidexteriteit aangewezen kan zijn wanneer project teams zich met unieke uitdagingen en strikte beperkingen geconfronteerd zien. Deze PhD thesis bestaat uit drie artikelen omtrent ambidexteriteit in projecten.

Ondanks diverse studies de prestatie-impact van ambidexteriteit bewijzen, is er nog steeds een tekort aan onderzoek dat empirisch verduidelijkt hoe exploitatie en exploratie kunnen gecombineerd worden in de praktijk. De eerste en tweede studie behandelen deze vraag. Beide studies zijn gebaseerd op case studie bevindingen van eenzelfde project in een toonaangevend, internationaal, chemisch bedrijf. De doelstelling was om holistisch en diepgaand één project te onderzoeken. Data werd verzameld door observatie, interviews, overleg, en analyse van werkprocedures. Een andere onduidelijkheid in ambidexteriteit onderzoek betreft de impact van ambidexteriteit op werknemers hun mentale gezondheid. De derde studie onderzoek op basis van enquêtes (n=183) of een individuele project medewerker die exploitatie en exploratie moet combineren bij de dagelijkse projectwerkzaamheden, ook een hogere job vermoeidheid ervaart.

De eerste studie illustreert hoe de vier antecedenten van ambidexteriteit de bekwaamheid om exploitatie en exploratie te combineren in een project kunnen verklaren. We beschrijven hoe een project team in een chemisch bedrijf succesvol exploitatie en exploratie combineerde gedurende een turnaround project dat een stilstand van de installatie vereiste. Hierbij (1) werden alle vier de antecedenten waargenomen (i.e., structurele, sequentiële, contextuele, en leiderschap-gebaseerde antecedenten). Verder werden (2) geen spanningen en (3) enkele voorbeelden van complementariteit tussen antecedenten waargenomen. De bevindingen van de case studie toont aan dat het mogelijk is project ambidexteriteit te verklaren door een combinatie van de vier antecedenten. Een specifieke focus dat niet alle vier de antecedenten en diverse analyseniveaus beschouwt, kan het effect van de beschouwde antecedenten overschatten gezien deze mogelijks slechts deels de effectiviteit verklaren. Verder onderzoek is nodig om de veralgemeenbaarheid van de bevindingen te verifiëren.

De tweede studie onderzoekt hoe een cluster van management controle mechanismen de exploitatie en exploratie tijdens het project stimuleerden en mogelijk maakten. De resultaten tonen dat een hybride cluster van controle mechanismen, een combinatie van diverse uiteenlopende mechanismen, resulteerde in zowel exploitatie als exploratie. Verder beschrijven we hoe combinaties van controle mechanismen gebruikt werden om exploitatie en/of exploratie te bekomen, waarbij de nadruk op controle mechanismen en hun invloed op exploitatie en/of

exploratie varieerde gedurende de project fases. Geen onverenigbare noden voor exploitatie en exploratie werden opgemerkt wanneer deze gecombineerd werden, wat een orthogonale benadering staafde. Verder vonden we dat de hybride controle cluster zowel single als double loop leren stimuleerde. Dit leren zorgde voor een tijdige aanpassing van de cluster met management controle mechanismen aan wijzigingen in de complexe en dynamische omgeving.

De resultaten van de enquête in de derde studie toonden aan dat een individuele project medewerker die meer exploitatie en exploratie moet combineren in zijn dagelijkse projectwerkzaamheden, ook een hogere job vermoeidheid ervaart. Verder tonen de resultaten dat Karasek zijn demand-control-support-model ook een aanzienlijke variatie in job vermoeidheid verklaart zoals reeds door eerder onderzoek aangetoond werd. We vonden dat een toenemende job vermoeidheid te wijten kon zijn aan een hoger niveau van job vereisten, minder controle over de job en minder steun van collega's en oversten. Een aanzienlijk groter deel van de variantie werd verklaard door Karasek zijn demand-control-support-model dan door verschillen in ambidexteriteit. We vonden ook een positief interactie-effect tussen ambidexteriteit en job controle. Ambidexteriteit zwakt het gunstige effect af dat job controle heeft op job vermoeidheid.

Ambidexterity and management control packages

PhD Dissertation

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Introduction

Since March's (1991) article almost **30 years of ambidexterity research** has been done. Ambidexterity concerns the ability to manage *"the relation between the exploration of new possibilities and the exploitation of old certainties"*. (March, 1991, p. 71) He gave two very broad descriptions of both concepts: **"Exploration** includes things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation. **Exploitation** includes such things as refinement, choice, production, efficiency, selection, implementation, execution." (p. 71)

The assumption of **incompatibility** between exploration and exploitation was widespread before March's article (1991). March (1991) found that organizations need to divide attention and other resources between exploitation and exploration (March, 1991). If too much resources are contributed to exploration, to the exclusion of exploitation, this could result in a costs of experimentation without gaining many of the returns of its knowledge. The pursuit of new knowledge, of things that might come to be known, can result in too many undeveloped new ideas and too little distinctive competence (March, 1991; Levinthal & March, 1993). If too much resources are contributed to exploitation, the use and development of things already known, to the exclusion of exploration, this could result in obsolescence and suboptimal stable equilibria (March, 1991; Levinthal & March, 1993). March (1991) concluded that firm's need an appropriate balance between exploitation and exploration in view of survival and prosperity. Or as later stated by Levinthal, and March (1993, p. 105): *"The basic problem confronting an organization is to engage in sufficient exploitation to ensure its current viability and, at the same time, to devote enough energy to exploration to ensure its future viability."*

Tushman, and O'Reilly (1996) indicated that this implies **contrasting managerial demands**. In the short run managers must increase the fit or alignment of strategy, structure, and culture to make their organizations successful. In the long run, however, sustained success may require from managers to periodically destroy what has been created in order to reconstruct a new organization better suited for the next wave of competition or technology. Periods of relatively stability and incremental innovation are alternated with revolutionary changes. Nevertheless, most organizations only react when they face a performance decline. Only a small minority of farsighted firms are capable to initiate proactive change (Tushman & O'Reilly, 1996). It illustrates the relevance and value of studies that unfold the capability of some firms to demonstrate a high level of ambidexterity.

Later research demonstrated that ambidexterity has a positive impact on **many different firm performance aspects** above firm survival, e.g. sales growth, subjective ratings of performance, innovation, and market valuation as measured by Tobin's Q (O'Reilly & Tushman, 2013). The positive association of ambidexterity and firm performance is reinforced by certain **characteristics of the firm and the firm's environment**. Ambidexterity is more beneficial for a larger firm, when a firm has more resources at its disposal, and when the firm's environment is characterized by a higher uncertainty or increased competitiveness (O'Reilly & Tushman, 2013). Nevertheless, O'Reilly, and Tushman (2013) considered different empirical and theoretical ambidexterity papers, relying on anecdotal evidence, case studies, large samples with longitudinal data, literature reviews etc. They concluded: *"despite using different measures of ambidexterity, a range of outcome variables, different levels of analysis, and samples from differing industries, the results linking ambidexterity to performance are robust."* (O'Reilly & Tushman, 2013, p. 326). The impact on diverse performance aspects clarifies the ongoing interest during the past 30 years for ambidexterity research. This **PhD dissertation** has further elaborated on this research. In specific we focused on project businesses and handled three related aspects. First, we unravelled the **antecedents of ambidexterity** and their relatedness in one project

case. Second, we unravelled for the same project case how a **hybrid management control package** was used to successfully manage project ambidexterity. Third, we investigated which factors drive **job fatigue** in a project context by means of a survey across different project businesses.

Before laying hands on the research topics, all concepts must be clearly defined. Numerous, very diverse studies lacked transparency in the vocabulary that is used and made that the ambidexterity debate “*has become disconnected and complex*” (Raisch & Birkinshaw, 2008, p. 376). The **original meaning of ambidexterity** was “*an individual's capacity to be equally skillful with both hands*” which has been adapted to “*an organization's capacity to do two different things equally well*” (Birkinshaw & Gupta, 2013, p. 287). This generic definition for organizational ambidexterity, as the ability of a firm to do two things simultaneously, is quite vague and allows some confusion (O'Reilly & Tushman, 2013). A similar confusion exists about the meanings of exploration and exploitation (O'Reilly & Tushman, 2013). The versatility makes that organization ambidexterity was applied to a **wide variety of phenomena in recent years** (Birkinshaw & Gupta, 2013) which made it difficult to compare specific effects (Raisch & Birkinshaw, 2008, p. 376). The variation in underlying meaning and measures make that very different phenomena were categorized as exploration and exploitation (O'Reilly & Tushman, 2013). In addition, diverse studies demonstrate a wide variation in how ambidexterity is operationalized. Some use the sum or absolute difference of exploration and exploitation, others the product of the two, and still others prefer separate measures for both or some type of unidimensional or continuous measure (O'Reilly & Tushman, 2013). Because this diversity in underlying phenomena, definitions, and measures, **varying antecedents and outcomes** were found depending on the specific definition and context (O'Reilly & Tushman, 2013).

There is a **need for some refocusing and rethinking** (Birkinshaw & Gupta, 2013). **Potential confusion partly stems** from the **way ambidexterity is defined and measured** (Birkinshaw & Gupta, 2013; O'Reilly & Tushman, 2013). For that reason we focused mainly on literature review papers (Gupta, Smith, & Shalley, 2006; Raisch & Birkinshaw, 2008; Raisch, Birkinshaw, Probst, & Tushman, 2009; Simsek, Heavey, Veiga, & Souder, 2009; Birkinshaw & Gupta, 2013; O'Reilly & Tushman, 2013) as well as some research papers (e.g. March, 1991; Tushman & O'Reilly, 1996; O'Reilly & Tushman, 2011) to clearly **define the concepts** in the dissertation. We also refer to these works to indicate gaps within the literature and the different research streams that still need to be tackled in ambidexterity research to become a real research paradigm.

Ambidexterity

Organizational ambidexterity is an organization's **ability** to explore and exploit, despite this requires organizations to reconcile internal tensions and conflicting demands in their task environments (Raisch & Birkinshaw, 2008). However, definitions of exploration and exploitation differ in different studies (Raisch & Birkinshaw, 2008). Raisch, and Birkinshaw (2008) summarize various literature streams – such as organizational learning, technological innovation, organizational adaptation, strategic management, and organizational design – and illustrate the **different definitions** for exploration and exploitation in various literature streams.

For **organizational learning**, Raisch, and Birkinshaw (2008, p. 377) concluded that “*A group of researchers defined exploitation as the mere reuse of existing knowledge and thus assigned all instances of learning to exploration*” whereas other scholars “*differentiated between exploitation and exploration by focusing on the type or degree of learning rather than the presence or absence of*

learning” (p.377). The last category for instance classified according to different modes of organizational learning, such as double-loop versus single-loop learning (Raisch & Birkinshaw, 2008)

Technological innovation mainly framed exploration and exploitation by means of the distinction between incremental and radical innovation (Raisch & Birkinshaw, 2008, p. 378). *“Incremental innovation represents relatively minor adaptations of existing products and business concepts. In contrast, radical innovation refers to fundamental changes leading to a switch from existing products or concepts to completely new ones.”* A well-known work in this area is the one of Tushman, and O’Reilly (1996, p. 24) who literally referred to organizational ambidexterity as *“The ability to simultaneously pursue both incremental and discontinuous innovation and change”*.

Many scholars in **organizational adaptation** approach ambidexterity as the balance between continuity and change (Raisch & Birkinshaw, 2008, p. 379). *“These theories’ common underlying belief is that too many (or too radical) change actions could create organizational chaos if continuity is not taken into account, whereas the opposite could lead to inertia (Huy, 2002; Levinthal & March, 1993; Sastry, 1997).”*

With regard to **strategic management**, Raisch, and Birkinshaw (2008, p. 380) refer to influential work of various authors. Some research considered exploitation as applying or even leveraging existing competences and capabilities and exploration as the development or search for new ones. Other definitions define exploitation and exploration as variation-reducing, induced strategic processes and variation increasing, autonomous strategic processes, as static efficiency and dynamic efficiency, or as selective and adaptive strategic actions.

Organization design literature focuses on *“the challenge of using organizational features that make efficiency and flexibility possible.”* (Raisch & Birkinshaw, 2008, p. 380) This literature stream defines ambidexterity as *“a firm’s ability to operate complex organizational designs that provide for short-term efficiency and long-term innovation”* (Raisch & Birkinshaw, 2008, p. 380)

Besides the literature stream, definitions of ambidexterity, exploration, and exploitation also differ based on the **unit of analysis**. Some years ago Birkinshaw, and Gupta (2013, p. 291) analyzed 19 empirical papers published in top academic journals and used this evidence-based line of inquiry to find out how researchers had actually been conceptualizing and operationalizing the ambidexterity concept. They concluded that studies typically take either the firm or the business unit (in multi-business-unit firms) as the level of analysis. Furthermore, they indicated other studies take level of the individual, the team, the alliance or inter-organizational relationship, and the (corporate venturing) unit. An important finding was that in most of the studies the tensions that ambidexterity at a certain level create were solved at the next organizational level down (Birkinshaw & Gupta, 2013). Raisch et al. (2009) noticed that ambidexterity was mostly created by structural separation the next organizational level down: between functions or subdivisions within a business unit, between different teams in a manufacturing plant, between individuals with different roles within a single team etc. They noticed that only a few leaders need to act ambidextrously by integrating exploitative and explorative activities and for most ambidexterity studies *“structural mechanisms are used to enable ambidexterity, whereas most individuals are seen as focused on either exploration or exploitation activities”* (p. 687) Despite there is plenty of prior ambidexterity research focused at the macro level, such as the firm or business unit, there is a shortage of empirical studies that examine the construct at a more micro level (Nosella, Cantarello, & Filippini, 2012). Nosella, Cantarello, and Filippini (2012) pledge to shift attention from the macro to the **micro level**, e.g. a single organizational process, **project**, or phase, to study what **solutions** firms find to **resolve specific tensions**.

The unit of analysis is important to take the right definitions in the dissertation. We need to consider the **possibility of ambidexterity at the individual level** as well in all three papers. In the first paper project ambidexterity is unraveled relying on antecedents of ambidexterity. Contextual and leadership-based ambidexterity both imply a combination of exploration and exploitation at the individual level. The second paper examines how the control package stimulated individuals towards exploration, exploitation, or both. Again definitions of exploration and exploitation must be appropriate for the individual level of analysis. The third paper even focuses on individual project worker who needs to combine exploration and exploitation in his daily project work. So again definitions of exploration and exploitation must be appropriate for the individual level of analysis. Not all definitions of exploration and exploitation can be applied at the individual level of analysis. To consider the possibility of ambidexterity at the individual level we use simple definitions of exploration and exploitation that make a distinction between acquiring new knowledge and capabilities versus the reuse of earlier knowledge and capabilities.

Definitions of exploration and exploitation

Exploration is defined as the development or search for new knowledge, competences and capabilities.

Exploitation is defined as reuse and refinement of existing knowledge, competences and capabilities.

So we equated exploitation with the reuse of earlier knowledge, competencies and capabilities, whereas exploration was equated with acquiring new knowledge, competencies and capabilities.

The next step is the definition of ambidexterity. Birkinshaw, and Gupta (2013) found four ways to operationalize ambidexterity: (1) as an organization's **propensity** to do something, (2) as an organization's **intentions** to do something, (3) as **outcomes** from what the organization actually did, and (4) as an organization's **capacity** to do something. We prefer to operationalize ambidexterity as an ability/capacity which fits best with the dissertation its focus on management of ambidexterity and is preferred by many influential ambidexterity researchers. Raisch, and Birkinshaw (2008) already defined ambidexterity as an **ability**. Also Nosella et al. (2012) argue for a return to the original definition of ambidexterity that describes the construct as **capability** for resolving tensions. It was also repeated by Birkinshaw, and Gupta (2013) who were persuaded that firms exist to do things that markets cannot. They meant that markets only allocate resources efficiently to their short-term best use. They considered a market-based approach even as an efficient way for resource allocation when no difficult choices are to be made about the relative emphasis on exploration and exploitation. However, when such trade-offs and creative solutions are needed, firms are essential to manage the tensions that exist between competing objectives and achieve some form of ambidexterity (Birkinshaw & Gupta, 2013, p. 290). Firms exist because these have the **capacity** to do such difficult things. Firms allow a trade-off between short- and long-term demands and take multiple criteria into consideration when allocating scarce resources among competing priorities (Birkinshaw & Gupta, 2013). This is why Birkinshaw, and Gupta (2013, p. 291) refine ambidexterity as *"an organization's **capacity** to address two **organizationally incompatible objectives equally well.**"* They consider ambidexterity as a useful way of framing the challenges organizations face in managing two competing objectives at the same time and delivers the frameworks and tools for understanding the ability. Birkinshaw, and Gupta (2013) mainly attributed a firm's capacity to reconcile difficult tasks to managerial competence. Firms *"need managers who **can make** thoughtful trade-offs between competing demands, and who **can find** creative solutions that transcend either/or solutions"* (Birkinshaw, & Gupta, 2013, p. 290). Also Turner, Swart, and Maylor (2013) emphasized in their extensive literature review that ambidexterity does not refer to the managerial 'activity' but to **the 'capability' to combine exploration and exploitation.**

Turner, Swart, and Maylor again defined ambidexterity as an ability (2013, p. 320). “*Ambidexterity is the **ability to both use and refine existing knowledge (exploitation)** while also **creating new knowledge** to overcome knowledge deficiencies or absences identified within the execution of the work (**exploration**).*” And also O’Reilly, and Tushman (2013, p. 331) indicate that the core of ambidexterity consists of how managers and organizations are able to overcome the practical tensions to deal with both exploration and exploitation.

The definition we use in the dissertation is that ambidexterity is the ability to combine exploration and exploitation.

Definition of ambidexterity

Ambidexterity is defined as the ability to combine exploration and exploitation. (Turner, Swart, & Maylor, 2013)

Project ambidexterity is defined as the ability to combine of exploration and exploitation within a project. Ambidexterity at the individual level is defined as the ability to combine exploration and exploitation by an individual.

Exploration and exploitation: Incompatible, two-ends-of-one-continuum or orthogonal concepts?

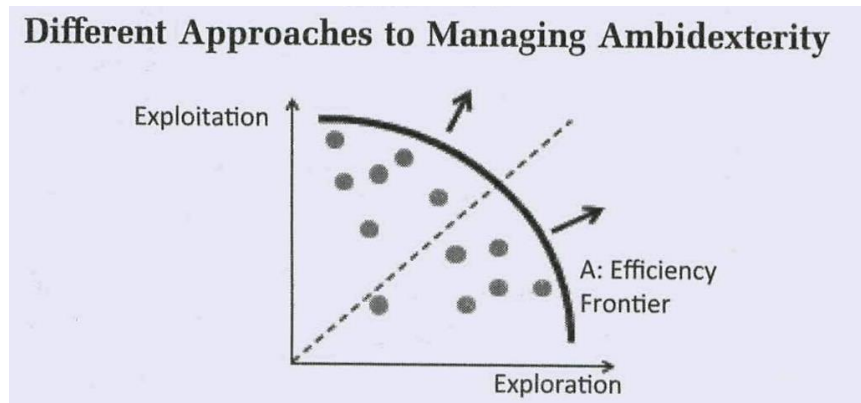
Some earlier research claimed that organizations could not build practices able to simultaneously address efficient exploitation and effective exploration (Raisch & Birkinshaw, 2008). These studies thus had the conviction that exploration and exploitation are **incompatible**, ambidexterity was not possible, and organizations must choose for the one or the other. The assumption of incompatibility between exploration and exploitation was widespread before March’s article (1991). March (1991) concluded that firm’s need both exploitation and exploration and was the start of ambidexterity literature.

Nevertheless, ambidexterity studies can still be divided according to the assumed tensions when combining exploration and exploitation. Some studies consider ambidexterity as balancing seemingly contradictory needs for exploitation and exploration (Raisch & Birkinshaw, 2008). This is the **two ends of one continuum** approach: two opposing ends are balanced. Raisch, and Birkinshaw (2008) even refer to balancing seemingly contradictory tensions. Since the beginning of this age, an increasing amount of studies do no longer assume such tensions. Current research often models exploitation and exploration as two fundamentally distinct **orthogonal** concepts that can be pursued fully and concurrently to attain competitive advantage and long term survival (Simsek et al., 2009, p. 867). Ambidexterity is then not about achieving the same levels of or some balance between exploration and exploitation, but about maximizing the attainment of both (Simsek et al., 2009, p. 867). Consideration of exploration and exploitation as orthogonal concepts is nowadays accepted by many ambidexterity researchers (e.g., Gupta et al., 2006; Simsek et al., 2009; Uotila, Maula, Keil, & Zahra, 2009; Turner et al., 2013...).

Nowadays many studies still struggle with the modelling of exploration and exploitation. Mostly they do not explicitly mention the conceptualization as either two ends of one continuum or orthogonal concepts. “*The ambidexterity literature is extremely vague on whether two different objectives should be balanced, traded off against one another, reconciled, or simply managed.*” (Birkinshaw & Gupta,

2013, p. 295) For that reason, Birkinshaw, and Gupta (2013) used a diagrammatic way to clarify terminology.

Figure 1: Different approaches to managing ambidexterity (Birkinshaw & Gupta, 2013)



Birkinshaw, and Gupta (2013) concluded that management of ambidexterity comprises three aspects. First, organizations must choose where to sit on the efficiency frontier. Second, they must try to reach the efficiency frontier. And third, they must push the efficiency frontier out.

In general, all positions on the frontier can be equally valid choices. In practice, some positions on the efficiency frontier may actually be superior to others, depending on the exact circumstances facing the firm (Birkinshaw & Gupta, 2013). If they actually reach that position on the efficiency frontier can depend on the available (managerial) capabilities, and the ability to reconcile different objectives (Birkinshaw & Gupta, 2013). And once the efficiency frontier is approached or reached, the remaining question is then how the efficiency frontier can be pushed out up and to the right, to allow a higher level of ambidexterity than previously possible (Birkinshaw & Gupta, 2013).

Birkinshaw, and Gupta (2013) indicated the need for further research that clarifies all three generic sets of choices. They do indicate a need for ambidexterity research that figures out where on the efficiency frontier to sit, and under what circumstances. On the one hand, studies that operationalize ambidexterity as the **product or sum** of exploration and exploitation, unsurprisingly, find that the firms **closest to the frontier** are the higher performers (Birkinshaw & Gupta, 2013). It is indeed logical that firms that score high on exploitation and exploration, are high performers. On the other hand, studies that focused on the **balance** implicitly pursue that *“the desirable place to sit is on the bottom-left to top-right diagonal, whether this is close to the efficiency frontier or not (Lin, Yang, & Demirkan, 2007; Rothaermel & Alexandre, 2009)”* (Birkinshaw & Gupta, 2013, p. 295).

We use Birkinshaw, and Gupta (2013) their model to illustrate that the two ends of one continuum view and the orthogonal view do not need to be inconsistent. In fact their diagram considers exploration and exploitation as **two orthogonal activities** as long as their combination is **below the efficiency frontier**. Both are separate dimensions instead of poles on a continuum. A firm that has not reached the efficiency frontier can improve on both exploration and exploitation, which seems to us an illustration of the orthogonal view. However, when the efficiency frontier is reached there is a trade-off. Firms cannot achieve a higher level of exploration or exploitation, without losing on the other aspect. Exploration and exploitation act as **two opposing ends on the efficiency frontier**. But even then technological developments and innovations in management techniques, for instance, may enable firms to improve their work processes, thereby allowing a higher level of ambidexterity (i.e., reconciliation of two different objectives) than was previously possible (Birkinshaw & Gupta, 2013).

My conclusion is that an increase on both exploration and exploitation, so without trade-offs, does not necessarily proof that only an orthogonal view is possible. When considering the diagram, an increase on both exploration and exploitation is possible as long as the current position is under the efficiency barrier. If increasing on exploration and exploitation inevitably causes a decrease on the other aspect, this trade-off could signal that the current combination is positioned on the efficiency barrier and the two ends of one continuum approach could be appropriated.

There are different ways how researchers operationalize ambidexterity. Some studies use a unidimensional or continuous measure, other studies use the sum, absolute difference or product of exploration and exploitation, and still others prefer to separate measures of exploration and exploitation (O'Reilly & Tushman, 2013). Both Birkinshaw, and Gupta (2013) and O'Reilly, and Tushman (2013) considered exploration and exploitation as separate constructs. In case these are considered as separate constructs, both should be measured as such as well (O'Reilly & Tushman, 2013). In paper 1 and 2 of this **dissertation**, exploration and exploitation are modelled as **orthogonal concepts** and **measured separately**. It seems most appropriate considering, as illustrated by the diagram, most achievable combinations are positioned under the efficiency frontier. Many firms still need to improve on managerial capabilities and ability to reconcile different objectives, to simply match the level already achieved by others (Birkinshaw & Gupta, 2013). And even if the efficiency frontier is reached, technological developments and **innovations in management techniques**, for instance, may enable firms to improve their work processes, thereby allowing a higher level of ambidexterity (i.e., reconciliation of two different objectives) than was previously possible (Birkinshaw & Gupta, 2013). Consideration of exploitation and exploration as distinct, orthogonal concepts imply that **no interdependencies between exploitation and exploration** are considered for the operationalization of ambidexterity.

Measure of ambidexterity

In **paper 1** and **paper 2**, separate measures for exploration and exploitation are used.

Paper 3 handles the effect of ambidexterity at the individual level on job fatigue and uses a combined measure for ambidexterity to consider the combined effect of exploration and exploitation. As a result, we prefer the sum of exploration and exploitation to operationalize ambidexterity as a weighted combination of both.

Measure of ambidexterity

In **paper 3**, ambidexterity is operationalized as the sum of exploration and exploitation.

Management of ambidexterity

Every firm strives for success. Nevertheless, there is a dark side to success: Successful firms become **older**, and **larger** to handle the increasing complexity but like this often develop **structural** and **cultural inertia** (Tushman & O'Reilly, 1996). **Structural** and **cultural inertia** create a resistance to change. The firm's culture can be an effective way of controlling and coordinating people towards ongoing success in relatively stable environments. When confronted with dynamic environments, however, a culture can become a significant barrier to change and cause organizational complacency and arrogance. **Cultural** inertia consist of such informal norms, values, social networks, myths, stories, heroes... linked to earlier successes that get institutionalized over time but create some shared expectations that impede change. Cultural inertia thus mainly origin from **age** and **success**. In case of **structural** inertia it becomes more difficult, costly, and time-demanding to institute changes because of the size, complexity, and interdependence in the institutionalized organization's structures, systems, procedures, and processes (Tushman & O'Reilly, 1996).

A firm needs to host multiple contradictory structures, processes, and cultures to overcome structural and cultural inertia (Tushman & O'Reilly, 1996). This can be achieved by combining a diversity of **organizational architectures**, **multiple cultures**, and **ambidextrous managers** (Tushman & O'Reilly, 1996). **Organizational architectures** need to achieve a delicate balance among size, autonomy, teamwork, and speed. Organizational size is used to leverage economies of scale and scope, but at the same time units are kept small and decision-making is decentralized. Within these small and autonomous units employees get ownership and responsibility to achieve results. Fragmentation does not result in a loss of synergy because the reliance on strong social controls. **Multiple cultures** need to be used to create some tight-loose aspect that is crucial for ambidextrous organizations (Tushman & O'Reilly, 1996). The glue that holds these organizations together is a strong, broadly shared corporate culture with a tight emphasis on norms critical for innovation such as openness, autonomy, initiative, and risk taking. This broadly shared overall culture can provide consistency, predictability, and trust, stimulate sharing of information and resources, and further integration. But at the same time the culture still needs some looseness to allow necessary variations across business units. Rewards and culture promote local autonomy, risk taking, and high performance while local responsibility and accountability through strong, consistent financial control systems, and information sharing ensure consistency. **Ambidextrous managers** must be able to cope with the varied organizational architectures and the multiple cultures (Tushman & O'Reilly, 1996). These managers' ability to manage units with varied structures and cultures mostly stems from a relatively long tenure in the organization whereby they have become familiar with the organizational architectures and have become the embodiment of the corporate culture. This long history in the firm may not impede their willingness to change continuously to meet the future. These managers do not let their organization become arrogant and complacent, but keep everyone humble, modest, and focused on a striving for renewing.

Despite Tushman, and O'Reilly (1996) their work more than 20 years ago, ambidexterity literature nowadays still needs more research to clarify **how ambidexterity** can be **managed**. This is partly because prior ambidexterity research mostly focused at the macro level, and ignored the fine-grained, multilayered nature of ambidexterity (Nosella, Cantarello, & Filippini, 2012). Nosella et al. (2012) considered ambidexterity as the capability to resolve tensions. Nosella et al. (2012) argue that ambidexterity should be defined as a **capability for resolving tensions**. They consider in line with Parmigiani, and Howard-Grenville (2011, p. 419) that such capability is comprised of *'high level routines and key inputs which together confer a set of decision options to produce an expected output'*. **Empirical studies** that examine a **smaller unit of analysis** would allow to **discover the organizational**

routines and practices used to resolve tensions in a specific context (Nosella et al., 2012). Nosella et al. (2012) also urge the necessity to look inside the specific tension and identify **how** the routines and key inputs are used to **develop the capability of resolving tensions**. A ‘practice-centered’ approach, e.g. by means of **case-based analysis** of ambidexterity, could clarify how routines and practices result in the development of the capability: *“looking at the internal working of specific routines [...] could provide the micro-foundations and key mechanisms used by firms to resolve tensions”* (Nosella et al., 2012, p. 460). Nosella et al. (2012) consider it highly probable that ambidexterity requires an ability to continuously adapt and reconfigure an organizational design over time to respond to changes in the environment and like this resolve the tensions that continuously arise. For that reason literature could also benefit from **longitudinal studies** whereas most studies adopted a cross-sectional approach (Nosella et al., 2012).

This PhD dissertation will consider **(1) how** a project organization is able to overcome tensions between exploitation and exploration, as well as **(2) the different management control practices** used to resolve the tensions. In the first paper, we focus on the configuration of exploration and exploitation, and the observed tensions, using the **antecedents of ambidexterity** approach. In the second paper, we bring into view the different management control practices, using a holistic **management control package** approach.

We will discuss the literature in two steps. First we discuss literature about **antecedents of ambidexterity** which is used in paper 1. Second we discuss the literature about **management control packages**. Afterwards we also consider literature about job fatigue that is used for paper 3.

Antecedents of ambidexterity

The antecedents of ambidexterity literature handles the way exploration and exploitation are combined. After two decades of literature, there is a focus on 5 dominant ways. These five are respectively known in ambidexterity literature as inter-organizational antecedents, sequential antecedents, structural antecedents, contextual antecedents, and leadership-based antecedents. **Inter-organizational antecedents** externalize either exploration or exploitation by means of outsourcing or alliances (Raisch, & Birkinshaw, 2008). **Structural antecedents** rely on structural separation between different units within the organization that are focused on either exploration or exploitation (Raisch, & Birkinshaw, 2008). Both inter-organizational and structural antecedents thus use structural separation, and the only difference is the level the ability to combine both is retrieved. For that reason, inter-organizational antecedents are sometimes considered as structural antecedents at the inter-organizational level, and not as a separate category. **Sequential antecedents** rely on temporarily cycling through periods of exploitation and periods of exploration (Raisch & Birkinshaw, 2008). The same individuals can switch back and forth between exploitation and exploration. **Contextual antecedents** imply that the individuals within some unit get the responsibility to combine exploration and exploitation (Raisch & Birkinshaw, 2008). A context that combines stretch, discipline, support, and trust enables and stimulates individual workers to contribute to both exploitation and exploration (Raisch & Birkinshaw, 2008). Important is thus that the context stimulates individuals whose exploration and exploitation efforts create the ambidexterity. In case of **leadership-based antecedents** the top management team is responsible to reconcile both (Raisch & Birkinshaw, 2008). Managers, top-down, stimulate a combination of exploration and exploitation. They can contribute themselves to both, and stimulate others to do so by implementing the other types of antecedents.

To unravel in practice the antecedents that contribute to ambidexterity, it is important to consider different antecedents **across levels of analysis** and **across time**. Ambidexterity is a "nested" concept, such that it transpires at multiple levels in the organization simultaneously (Birkinshaw & Gupta, 2013). Ambidexterity research that explicitly considers two or more levels of analysis simultaneously could contribute by clarifying how exploration and exploitation are reconciled across levels of analysis (Birkinshaw & Gupta, 2013). In addition, O'Reilly, and Tushman (2013) concluded that there is not one single way to handle ambidexterity and context or timing can influence what **combinations of antecedents** are most appropriate. (O'Reilly & Tushman, 2013, p. 330).

We will now discuss in depth the different antecedents of ambidexterity.

Inter-organizational antecedents resolve the tensions between the paradoxical requirements through externalization, e.g. by means of outsourcing or by establishing alliances, of exploitation or exploration (Raisch et al., 2009). Raisch et al. (2009) gave different examples and benefits of externalization of exploration, whereas they observed far less examples for externalization of exploitation. Nevertheless, Raisch, and Birkinshaw (2008), as well as Raisch et al. (2009) do not categorize strategic alliances as antecedents of organizational ambidexterity because organizations only engage in one activity at a time. They consider antecedents of organizational ambidexterity as a combination of exploitation and exploration, simultaneously and internally. But externalization of exploration or exploitation requires that a firm is able to integrate internal and external knowledge bases (Raisch et al., 2009). A firm can also combine inter-organizational and intra-organizational approaches to ambidexterity and these can be complements rather than substitutes (Kauppila, 2010). O'Reilly, and Tushman (2013) found several studies demonstrating that inter-organizational antecedents can create ambidexterity and this way have positive effects on firm performance. O'Reilly, and Tushman (2013) did not consider inter-

organizational antecedents as a separate category. They considered these as structural antecedents in inter-organizational or community settings rather than simply intra-organizational ones. In line we do consider external acquisition of either exploration or exploitation, and internal integration, as a form of structural antecedents.

Structural antecedents are mostly equated with spatial separation at the business unit or corporate level between units with configurations that are appropriate to pursue either exploitation or exploration (Raisch & Birkinshaw, 2008). The simultaneous pursuit of both occurs in separate subunits with different competencies, systems, incentives, processes, and cultures that are internally aligned (O'Reilly & Tushman, 2013). A theoretical discussion related to structural antecedents, is how these separated units should be integrated (Raisch & Birkinshaw, 2008). Raisch, and Birkinshaw (2008) notice different ways in literature: units focused on exploration can be completely separated from units focused on exploitation, organizations can use a loose coupling and strong buffering between units focused on either exploration or exploitation, or other studies even argue for a combination of tight and loose coupling.

Sequential antecedents imply that organizations achieve ambidexterity in a sequential fashion. Firms can shift structures after longer periods of time, which is more in line with the punctuated equilibrium type of change, to adapt the organization to change in environmental conditions. In that case, long periods with a focus on exploitation are alternated with exploration. Whereas this definition focuses on long-term adaptation processes, sequential ambidexterity is now more often used to describe cycling between shorter periods of exploitation and exploration. This is done by temporal cycling between parallel structures. Parallel structures allow people to alternate between two (or more) types of structures, that are suited for either exploitation or exploration (Raisch & Birkinshaw, 2008). Whereas a unit's formal primary structures can support stability and efficiency when doing routine tasks, additional secondary structures (e.g. project teams or networks) can coexist to allow flexibility for non-routine tasks and innovation (Raisch & Birkinshaw, 2008). When temporal cycling implies that organizations only focus at either exploration or exploitation at a time, Raisch, and Birkinshaw (2008) argue that ambidexterity needs both simultaneously and internally and do not consider such sequential separation as a type of antecedents. And even when exploitation and exploration are achieved simultaneously and internally, Raisch, and Birkinshaw (2008) categorize such temporal cycling between parallel structures as structural antecedents. Nevertheless, sequential antecedents are used to combine exploration and exploitation within one project (e.g. Liu & Leitner, 2012). O'Reilly, and Tushman (2013) also illustrated several examples of firms that are able to combine exploration and exploitation by means of temporal shifting. Studies describing "rhythmic switching" or "vacillation" between "semisttructures" demonstrate it is more easy to switch between formal structures than to change the culture and informal organization (O'Reilly & Tushman, 2013). Organizations can even plan sequential changes in organizational structure which is an effective way to promote temporarily a switch in focus between exploitation and exploration. (O'Reilly & Tushman, 2013). We categorize temporal cycling between parallel structures that focus on either exploration or exploitation as sequential antecedents and we do consider sequential antecedents as a separate relevant category of antecedents.

Contextual antecedents imply a supportive business-unit context that enables and encourages by means of systems, processes, and beliefs individual workers to judge for themselves how to best divide their time between the conflicting demands for exploitation and exploration (Gibson & Birkinshaw, 2004; Raisch & Birkinshaw, 2008; O'Reilly & Tushman, 2013). In a context where stretch, discipline, support, and trust are combined, individuals within a unit can demonstrate a behavioural capacity to simultaneously demonstrate exploitation and exploration (Gibson & Birkinshaw, 2004). So whereas

inter-organizational, structural, and sequential antecedents solve the exploration/exploitation tension through structural means, contextual antecedents solve the tension at the individual level by means of a supportive context (O'Reilly & Tushman, 2013). Clear differences are the emphasis on individuals rather than units that combine or alternate between exploitation and exploration, and the reliance on individuals their adjustment to achieve ambidexterity (O'Reilly & Tushman, 2013). Besides these direct effects, contextual ambidexterity can also facilitate other ambidextrous designs considering organizational culture and identity often contribute to the ability of hosting ambidextrous designs over time (O'Reilly & Tushman, 2013).

Nevertheless, literature assumes that exploration leads to a generation, selection, and adaptation of knowledge somewhere, and that this knowledge is also exploited, but it does not explain how contextual antecedents allow to simultaneously combine exploration and exploitation (Kauppila, 2010). Also O'Reilly, and Tushman (2013) indicate that it is still not known what exactly the organizational systems and processes are that enable and encourage these individual adjustments. Individuals can agree that they combine exploitation and exploration, without knowing the underlying mechanisms that made this alignment possible (O'Reilly & Tushman, 2013). How can firms and their leaders promote a context (e.g. new cultures and identities) that promote both exploitation and exploration considering a context that promotes the one may be inappropriate to pursue the other (O'Reilly & Tushman, 2013)?

Leadership-based antecedents have become considered by an emergent group of researchers as a separate type of antecedents in ambidexterity literature (Raisch & Birkinshaw, 2008). It is important to see the difference with contextual antecedents that assume individual workers are supported and encouraged to combine exploitation and exploration. The ability to be ambidextrous is in case of contextual antecedents created by bottom-up contributions of individuals, triggered by an appropriate work context. Leadership-based antecedents concern the top-down efforts of managers instead of the bottom-up efforts of subordinates. Leaders can demonstrate an ability to combine a focus on both exploitation and exploration. This ability can stem from their personal efforts to combine both. Managers can contribute to both exploitation and exploration and demonstrate ambidexterity at the individual level (Raisch et al., 2009). Managers themselves combine efforts for both and steer other people to focus on exploration and/or exploitation. *"Ambidextrous managers must manage contradictions and conflicting goals (Smith and Tushman 2005), engage in paradoxical thinking (Gibson and Birkinshaw 2004), and fulfill multiple roles (Floyd and Lane 2000)."* (Raisch et al., 2009, p. 687) The level of personal ambidexterity varies within and across contexts and depends on personal characteristics. Leadership can, for instance, be influenced by contextual factors such as the level of decision making authority managers get, formal senior team contingency rewards and informal senior team social integration (Raisch et al., 2009). Relevant personal characteristics include the ability to engage in paradoxical thinking, the access to knowledge inflows, or a range of prior related knowledge that can be helpful to assimilate and use new knowledge (Raisch et al., 2009). Personal characteristics and the organizational contexts can even interrelate, e.g. decision making authority can stimulate richer sense-making among managers (Raisch et al., 2009).

Besides their direct efforts for exploitation and exploration, another possibility is that managers support the implementation of other types of antecedents (Raisch & Birkinshaw, 2008). Leadership-based antecedents are valuable to implement structural, sequential or contextual antecedents. Managers are, for instance, responsible to create dual structural arrangements for structural antecedents or to create a supportive business-unit context for contextual antecedents (Raisch & Birkinshaw, 2008). Also O'Reilly, and Tushman (2013, p. 328) concluded that the most studies describing structural antecedents confirm that structurally separated autonomous units focused on

exploration or exploitation need *“targeted integration to leverage assets, an overarching vision to legitimate the need for exploration and exploitation, and leadership that is capable of managing the tensions associated with multiple organizational alignments”* It clearly indicates the need for an appropriate context and appropriate leadership-based antecedents to deal with the necessary integration in case of structural antecedents. O’Reilly, and Tushman (2013) argue that organizational ambidexterity, stimulated by structural, sequential, and contextual antecedents, is in fact an ability reflected in a complex set of decisions and routines for which managers are responsible. Ambidexterity is really hard to achieve; managers must make decisions to override the organization's tendency to go down the path of least resistance (Birkinshaw & Gupta, 2013). Managers need to make decisions about the reallocation of organizational assets to take advantage of new opportunities (O’Reilly & Tushman, 2013). To prevent, for instance, self-reinforcing behavioural routines, political games, and opportunism of individuals, organizations need managers that make the right choices and trade-offs among competing objectives (Birkinshaw & Gupta, 2013). Managers might, for instance, *“actively push one objective ahead of the other for a limited time”* or they can *“find creative ways of delivering on two objectives at the same time”* (Birkinshaw & Gupta, 2013, p. 293). Like this managers orchestrate the allocation resources to focus on both exploitation and exploration (O’Reilly & Tushman, 2013). These managers must also solve the tensions between the competing pressures of different organizational architectures. Nevertheless, it is unclear how leaders actually fulfil these requirements (Birkinshaw & Gupta, 2013; O’Reilly & Tushman, 2013). O’Reilly, and Tushman (2013), for instance, question how leaders can promote a context that promotes both exploitation and exploration. Furthermore, O’Reilly, and Tushman (2013) also see a need to leave the current intra-firm, organizational level of analysis and consider the larger community because there is a need for research about leadership capabilities required to lead across boundaries. More qualitative and in-depth studies are required to clarify how leaders actually reconcile exploitation and exploration, and manage the inevitable conflicts that arise (O’Reilly & Tushman, 2013).

A shortcoming of ambidexterity research is an overly focus on structural antecedents whereas other types of antecedents stay under-exposed (Raisch & Birkinshaw, 2008). We want to keep the conceptual clarity and will consider **structural, sequential, contextual and leadership-based antecedents separately**. We will not consider **inter-organizational antecedents** separately, but categorize these as structural antecedents at the inter-organizational level. Raisch, and Birkinshaw (2008) also noticed a lack of precision around the level of analysis. They argued to specify these levels of analysis because tensions at a certain level of analysis are often resolved at the next level down.

“All these levels of analysis are equally valid, but it is important that researchers are explicit about the level they are working at to avoid confusion and inconsistency. It is also important for researchers to distinguish between the level at which ambidexterity is held (i.e., where the tension between exploration and exploitation is felt) and the level at which it is resolved (e.g., where structural separation occurs).” (Raisch & Birkinshaw, 2008, p. 396-397)

The need for studies that span multiple levels of analysis is also present because such specification of the levels of analysis would allow to address how those levels interact with one another (Raisch & Birkinshaw, 2008). Literature mostly implicitly conceptualized different types of antecedents as alternative solutions, and interrelations between these antecedents should get more attention (Raisch & Birkinshaw, 2008). *“Future research could formally develop and test propositions on **how different antecedents interact and complement one another** in a firm’s pursuit of organizational ambidexterity. This could also provide interesting insights into how antecedents from different organizational levels are interrelated in firms’ pursuit of ambidexterity.”* (Raisch & Birkinshaw, 2008, p. 399) This view was

repeated by Birkinshaw, and Gupta (2013) who again argued for ambidexterity research that clarified how different objectives are reconciled across levels of analysis.

We will consider four types of antecedents: structural, sequential, contextual, and leadership-based antecedents. Furthermore, we will consider different levels of analysis. We will also consider interactions between different antecedents across different levels. Another aspect concerns the focus on project ambidexterity. All the above aspects are mainly focused on firm-level ambidexterity. Nevertheless, ambidexterity research still simplifies too much with regard to **boundary conditions** and would benefit from additional work taking a granular view of boundaries to deepen and refine its initial findings (Raisch & Birkinshaw, 2008). Most ambidexterity research, for instance, takes a system-level view while there are actually variations at the subsystem level (Raisch & Birkinshaw, 2008). *“Given this variety, the analysis of boundary contexts at the business unit or corporate level may be misleading. Rather than all-or-nothing prescriptions at the system level, more granular analyses and recommendations may be required.”* (Raisch & Birkinshaw, 2008, p. 401) Raisch, and Birkinshaw (2008) thus argue for complementing the system-level analysis with more-fine grained investigation of lower levels and the interrelations. In that respect, it could be useful to focus on ambidexterity at a lower level such as a project level.

There is relevant literature about **ambidexterity at a project level**. Liu, and Leitner (2012), for instance, investigated a complex infrastructure project facing unique challenges and a tight budget and schedule, by means of an in-depth case study. They focused on both the antecedents of ambidexterity and the effect of ambidexterity on project performance. They found that ambidexterity at the project team level was significantly contributing to project performance. This project ambidexterity was the result of sequential antecedents and contextual antecedents. Liu, and Leitner (2012) found no structural antecedents that led to ambidexterity at the project level and they did not explicitly consider leadership-based antecedents. Liu, and Leitner (2012, p. 97) further expressed why structural antecedents may be ineffective in a project context. Projects often require a cycling between exploitation and exploration but structural antecedents are ineffective considering separate efforts for exploitation and exploration need to be integrated under time pressure and resource constraints (Liu & Leitner, 2012). Liu, and Leitner (2012) their work thus definitely emphasizes the need to consider sequential antecedents and contextual antecedents. They (2012, p. 97) even illustrated how contextual antecedents facilitated sequential antecedents: *“The development of an effective project context can facilitate the temporal cycling between exploration and exploitation by creating awareness that overcomes the inertia in transitioning between the two by setting performance expectations and appropriate social context.”* The construct measuring the project context used in their study is, however, a composite construct. They used the sum of social context and performance context and described project context as *“the degree to which the project team was driven by the management team, project systems, and project environment to temporally separate activities of exploration and exploitation was measured (Nickerson & Zenger, 2002).”* (Liu & Leitner, 2012, p. 103) Gibson and Birkinshaw (2004) used a similar measure with multiplication instead of sum. This project context-construct, however, mingled elements of contextual as well as leadership-based antecedents which we will include separately.

Definition of antecedents

Structural antecedents rely on structural separation between different units that are focused on either exploration or exploitation.

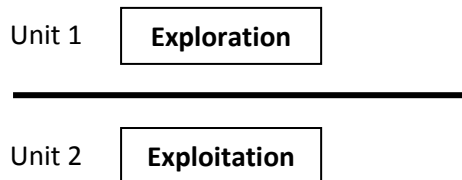
Sequential antecedents rely on sequentially switching between parallel structures that are focused on either exploration or exploitation.

Contextual antecedents imply a supportive business-unit context that enables and encourages individual workers by means of systems, processes, and beliefs to judge for themselves how to best divide their time between the conflicting demands for exploitation and exploration

Leadership-based antecedents imply that leaders actually reconcile exploitation and exploration.

Figure 2: Types of ambidexterity

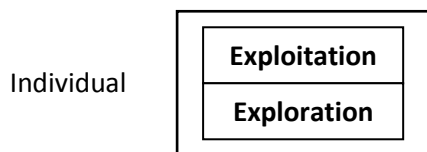
Structural ambidexterity



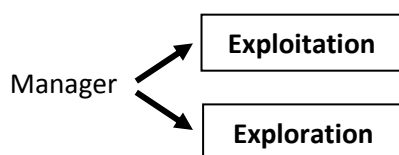
Sequential ambidexterity



Contextual ambidexterity



Leadership-based ambidexterity



Management control package

According to O'Reilly and Tushman (2011, p. 8), ambidexterity research misses comprehension of the specific **management actions** needed for ambidexterity. They ask for more understanding about what specific **micro-mechanisms** can be used to develop the ability to simultaneously pursue exploitation and exploration? In their literature review about concept of organizational ambidexterity, also Birkinshaw, and Gupta (2013, p. 294) considered it as a central concern in ambidexterity research to clarify how two different objectives might be effectively managed. They also indicated not much attention from ambidexterity researchers was devoted to understanding how the efficiency frontier, the maximum achievable combination of exploration and exploitation, can be shifted out. Birkinshaw, and Gupta (2013) consider it an important and valuable challenge for future ambidexterity research to investigate how ambidexterity is managed, not at least because it is really hard to achieve ambidexterity. Management research is considered as one of the areas where ambidexterity research has the most potential. A focus on organizations that demonstrate the managerial capability and successfully achieve could allow to really make progress on how ambidexterity is achieved. Birkinshaw, and Gupta (2013) argue for research that takes a more detailed look at the way organizations that demonstrate a high level of ambidexterity make their decisions, who gets involved in those decisions, and how those decisions are implemented.

Whereas the first study focuses on the combinations of exploration and exploitation and the tensions between both in one project case where a high level of ambidexterity was achieved, this **second paper** focuses for the **same project case** on the management practices that were used. The underlying literature is situated in the management control literature. Management control concerns all processes and mechanisms used by managers to influence individuals and groups towards certain objectives. We investigated in the second paper if a **hybrid management control package** was used to successfully manage project ambidexterity in that specific project case.

Bedford, and Malmi (2015, p. 6) described management control: as *“a set of processes and mechanisms used by managers to influence the behaviour of individuals and groups towards more or less predetermined objectives (Flamholtz et al., 1985; Langfield-Smith, 2007; Speklé, 2001).”* Management control concerns a very wide array of specific mechanisms (Bedford & Malmi, 2015), which are labelled as controls in this dissertation. In a way to balance parsimony and exhaustiveness of coverage, Bedford, and Malmi (2015) preferred a taxonomy above factor analysis. Factor analysis means one uses a list of possible controls and empirically reduces the variety to more manageable portions for a sample of firms. Nevertheless, literature has not advanced enough to a priori select the items that should be included (Bedford & Malmi, 2015). Bedford, and Malmi (2015, p. 5) relied on the earlier typology of Malmi, and Brown (2008) to develop a somehow broader typology of management controls. That typology specified theoretical categories of control a priori while trying to achieve a comprehensive coverage with the selected categories. This was achievable because there is a quite-developed stream of control literature that indicates the core dimensions of control to draw upon (Bedford & Malmi, 2015). The control categories in Bedford, and Malmi (2015) are planning, measurement, compensation, structure, policies and procedures, and socio-ideological.

Grabner, and Moers (2013), however, mentioned quite some critical reviews for the reductionist approach used in most management control research that focuses on **single MC** practices related to budgets, performance measures, incentives, etc. *“Reductionism assumes that MC practices can be examined independently of other MC practices and it is this independence assumption that has been heavily criticized.”* (Grabner & Moers, 2013, p. 407) Grabner, and Moers (2013, p. 407) noticed both

theoretical and empirical responses: *“theorists have put forward the systems approach to contingency theory and empiricists have begun to examine combinations of MC practices that form packages or systems.”* Empirical research should consider management control packages, configurations or systems instead of categories of management controls. There was quite some ambiguity about what was meant by a “package” or “system” because these two literature streams - the theoretical one and the empirical one – had developed quite independent of each other (Grabner & Moers, 2013). Grabner, and Moers (2013) addressed this ambiguity both from a conceptual and empirical perspective. To understand these, the concept of interdependence must be clear. Interdependence between control practices means that the value of one control depends on the use of another control (Grabner & Moers, 2013). Decision makers can maximize performance if they decide (simultaneously) on multiple controls, and address issues between different controls to strive for internal fit between the controls (Grabner & Moers, 2013). An important remark is the difference between a contingency approach to fit, a congruence approach to fit, and complementary theory made by Grabner, and Moers (2013). **Contingency theory** considers the fit of the management controls and the context. Studies that take a contingency approach to fit will examine the performance effects of a combination of management control(s) and context. A **congruence approach** to fit will examine the association between a MC practice and context. **Complementarity theory** considers the mutual fit between the management controls. However, *“complementarity theory gives more substance to what a system is and thus also to how a system fits with context, both of which are the core components of the systems fit to contingency theory”* (Grabner & Moers, 2013, p. 408). Grabner, and Moers (2013) further demonstrated that at the conceptual level, both approaches rely on the same type of “systems fit”. Fit between controls can depend on fit with the context and such fit with the context can have performance effects.

The consideration of relations between controls is important to distinguish between packages or systems. Management controls form a **system** *“if the MC practices are interdependent and the design choices take these interdependencies into account”* (Grabner & Moers, 2013, p. 408). A **control package** is *“the complete set of control practices in place, regardless of whether the MC practices are interdependent and/or the design choices take interdependencies into account”* (Grabner & Moers, 2013, p. 408). A control package tries to give a holistic view of the complete collection or set of controls and control systems in place (Malmi & Brown, 2008; Grabner & Moers, 2013): *“the MC package can be composed of a set of MC systems and/or of a set of independent MC practices.”* (Grabner & Moers, 2013, p. 408). The diverse MC systems and/or independent MC practices can, for instance, coexist because they are used to address unrelated control problems (Grabner & Moers, 2013, p. 408). The notions of control packages and control systems cannot be interchanged considering a system assumes *“conscious decisions on the design of interdependent controls”* (Grabner & Moers, 2013, p. 409). Using a package or system view can depend on the purpose of the study. If relationships among controls are examined one looks for some system of controls, whereas MC are viewed as a package if one describes observed MC clusters but does not consider interrelations (Grabner & Moers, 2013). Considering a package is a collection or set of controls and control systems, it becomes even more complicated if a package controls and systems is described. Then it is crucial to first understand the various management control systems within the management control package (Grabner & Moers, 2013).

As mentioned before, individual controls can be classified conceptually (typologies) or derived empirically (taxonomies). A typology of controls can provide a list of controls, grouped in control categories, that can be included in a package (Grabner & Moers, 2013). Bedford, and Malmi (2015) used a typology of controls, quite similar to the one developed by Malmi, and Brown (2008), to investigate a taxonomy of control configurations. Bedford, and Malmi (2015) defined a **configuration** as *“a specific arrangement of multiple parts, components, elements, mechanisms, attributes, or the*

like.” (Bedford & Malmi, 2015, p. 2). In fact they examined the multiple controls and control systems that organizations actually have in place at the same time. Considering they do not consider any relations between the diverse elements, this is similar to the definition of a package.

Bedford, and Malmi (2015) investigated configurations by a cross-sectional sample of 400 firms. They found a taxonomy of five packages: simple control packages (C1), results (C2) and action (C3) control packages, devolved control packages (C4), and hybrid control packages (C5). Bedford, and Malmi (2015) also provided an understanding of the control logic underpinning each configuration and further validated each cluster. Nevertheless, empirical survey results demonstrated a tendency towards these five clusters, but do not allow to determine whether the solution presented is optimal (Bedford & Malmi, 2015). *“Generalization to existing conceptual frameworks and empirical (primarily case-based) research describing complex control structures in contemporary practice”* should now be used to provide further analytical validation (Bedford & Malmi, 2015, p. 13).

Definition of management control

Management control is defined as the set of management controls that managers use to influence the behavior of individuals and groups towards more or less predetermined objectives.

Management control **system** is a combination of interdependent management controls whereby interdependencies were taken into account when the system was designed.

Management control **package** is a set of management controls or even control systems in place that are independent or when design choices did not take interdependencies into account.

The second study will use empirical, case-based, research to verify what control package was used in one project case with a high level of ambidexterity. Furthermore the overall control package will, to the best of our ability, be disentangled into different control practices and systems that during the course of the project were applied.

Job Fatigue

Thompson (1967) and many other scholars after him described the Paradox of Administration. The paradox of administration has been an enduring idea in organizational theory (Adler, Goldoftas, & Levine, 1999). It implies that managers must choose between organization designs suited to routine, repetitive tasks and those suited to non-routine, innovative tasks, to strive for either efficiency or flexibility. The underlying idea is that striving for ambidexterity leads to **internal tensions** and **conflicting demands**. Substantial differences in routines and focus on learning, may hinder an individual or even subsystem to combine or even switch between routines of exploration and exploitation (Gupta et al., 2006). Combining both simultaneously will be easier for a group, organization or another larger system than for individuals (Gupta et al., 2006). Also Simsek et al. (2009, p. 869) mentioned:

*“Concurrently **pursuing exploitation and exploration** harmoniously within a single organizational unit is inherently challenging, because each competes for scarce resources, leading to **conflicts, contradictions, and inconsistencies**. In the absence of partitioning, this pursuit becomes intertwined in the ongoing operating and strategic activities of the unit and its culture, structure, and systems; placing a premium on its **members’ integrative abilities**.”*

Nevertheless, Gibson, and Birkinshaw (2004) discovered a capacity to simultaneously achieve alignment and adaptability at a business-unit that had its origins in a context characterized by a combination of stretch, discipline, support, and trust. Based on data collected from 4.195 individuals in 41 business units, they even found that such a context can result in ambidexterity and this ambidexterity mediates a relationship between the contextual features and performance. They labeled the capacity as contextual ambidexterity. Also Gilson, Mathieu, Shalley, and Ruddy (2005) did find that standardized work practices and creativity can be complementary in case of empowered teams. They found that standardization moderated the effects between creativity and team performance as well as between creativity and customer satisfaction. Raisch, and Birkinshaw (2008) gave an overview about **organization design literature that handles ambidexterity**. Despite some earlier studies argue that mechanistic and organic structures are difficult to reconcile within a single firm, they found more recent studies often do claim that mechanistic and organic structures can be reconciled. The complex organizational designs create the ambidexterity- ability to combine short-term efficiency with flexibility and long-term innovation.

Despite ambidexterity within empowered project teams or by means of complex organizational designs can be of high value for organizations, another aspect is the effect on individual coworkers if these need to reconcile conflicting demands. Striving for ambidexterity could affect an individual coworker's mental well-being (e.g. job-related tension or job fatigue). Job-related tension is more specific the *"tension arising from psychologically **stressful** circumstances in the job environment"* (Kenis, 1979, p. 712). Job-related stress is linked by literature with exhaustion, job fatigue... **Job fatigue** measures the extent to which employees feel fatigued at the end of a working day and have a need to recover (Van Yperen & Hagedoorn, 2003).

Wright, and Cropanzano (1998) found that **emotionally exhausted employees** exhibit **diminished job performance**. Locke, Smith, Erez, Chah, and Schaffer (1994) focused on intra-individual conflict in case individuals must combine a number of tasks or outcomes because multiple goals or tasks exist. Locke et al. (1994) found that for two sets of **conflicting goals** that conflict was **negatively related** to the **performance outcome** of at least one of both goals. An unexpected finding of Locke et al. (1994) was that the goal conflict effect was not mediated by commitment, goal priority, goal level or strategies. Locke et al. (1994) neither found moderator relationships/interaction effects. They asked for more research to find out what does mediate the effects of goal conflict on performance. Earlier studies illustrated that ambidextrous individuals, more specific ambidextrous managers, *"must manage contradictions and conflicting goals (Smith and Tushman 2005), engage in paradoxical thinking (Gibson and Birkinshaw 2004), and fulfill multiple roles (Floyd and Lane 2000)."* (Raisch et al., 2009, p. 687) If exploration and exploitation are conflicting goals striving for ambidexterity may exhaust individual coworkers. The **relation** between an individual's **striving for ambidexterity**, and thus combining of conflicting goals, and **job fatigue** will be the subject of the third paper.

An alternative model to explain variance in job fatigue, is **Karasek's demand-control-support model**. Karasek (1979) considered jobs with high demands but low control as high strain jobs. Employees who do not have the job control to handle these pressuring demands, pen up stress internally and end up exhausted (Karasek, 1979). Whereas Karasek (1979) used the term "exhaustion", we use **Job fatigue** as dependent variable just as, for instance, Van Yperen, and Hagedoorn, 2003. High job demands are associated with negative health-related outcomes. Increasing job demands were found to produce job fatigue and a need to recover (Van Yperen & Janssen, 2000). Van Yperen, and Hagedoorn (2003) found again that increasing job control can reduce job fatigue in case of high demand jobs. Increasing Job Social Support can also reduce job fatigue in case of high demand jobs (Johnson, 1989; Theorell & Karasek, 1996).

The **third paper** relies on survey research across different project businesses to investigate which factors explain variances in an individual project worker his job fatigue in a project context. The relation between an individual's level of ambidexterity and job fatigue is examined. Furthermore the study examines the main effects of job demands, job control, and job social support, as well as their respective interaction effects with ambidexterity, on job fatigue.

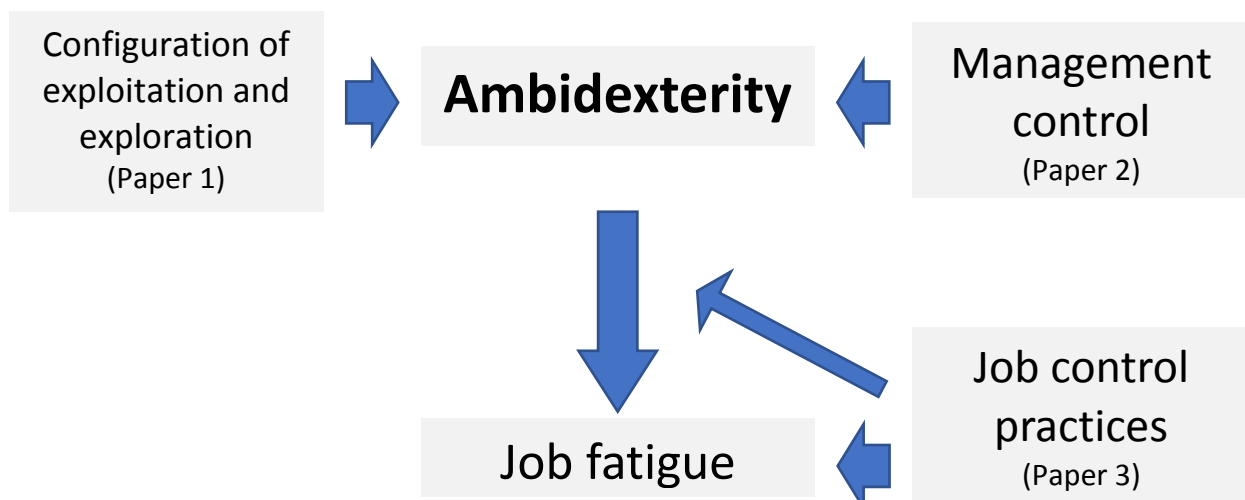
Structure of the dissertation

Based on literature, we defined some core concepts used in the dissertation. Ambidexterity is defined as the ability to combine exploration and exploitation within projects. Exploration means the development or search for new knowledge, competencies and capabilities. Exploitation means applying or leveraging existing knowledge, competences and capabilities. Ambidexterity gets much attention considering its association with organizational performance. Projects are one specific setting where ambidexterity can be required when project teams need to handle unique challenges while facing tight constraints. This dissertation consists of **three articles** regarding ambidexterity in projects.

Despite the vast amount of studies that proof the performance effects of ambidexterity, ambidexterity research only comprises a limited number of empirical studies that clarify **how exploration and exploitation are united in practice**. The **first and second study** address this question. Both studies rely on **case study evidence from the same project in one of the leading multinational chemical companies**. The objective was to perform a holistic and in-depth investigation of this successful project from two points of view. The **first study** examines how the four antecedents of ambidexterity can explain project ambidexterity. The **second study** examines how the management control package fostered exploration and exploitation during the project case. Data was collected through observation, interviews, meetings and analysis of procedure manuals.

Another loose end in ambidexterity literature concerns the **impact of ambidexterity on workers' well-being**. The **third study** relies on **survey data (n=183)** to examine if an individual project worker who needs to combine exploration and exploitation in his daily project work does experience a higher job fatigue. In addition, job demands, job control, and job social support, as well as their respective interaction effects with ambidexterity, are considered.

Figure 3: PhD Dissertation



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Paper 1: A project ambidexterity case: unravelling the antecedents of ambidexterity and their relatedness

A project ambidexterity case: unraveling the antecedents of ambidexterity and their relatedness

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Keywords: project, ambidexterity, structural antecedents, temporary/sequential antecedents, contextual antecedents, leadership-based antecedents, multi-level, case study

Paper category: qualitative case study research

Abstract: This study illustrates how the four categories antecedents of ambidexterity together explain project ambidexterity. Ambidexterity is here defined as the ability to combine exploitation and exploration. The majority of earlier empirical studies about ambidexterity are at the organizational level (Birkinshaw & Gupta, 2013), are quantitative (Turner, Swart, & Maylor, 2013), and are focused on structural, temporal, or contextual ambidexterity (Turner et al., 2013; Raisch & Birkinshaw, 2008). Despite some earlier qualitative research about project ambidexterity (e.g., Eriksson, 2013), we are the first to investigate *holistically* all four categories antecedents of ambidexterity by means of *qualitative* research. A case study was used for an in-depth investigation, and allowed a holistic overview. We describe how a chemical firm (nickname ChemBE) successfully achieved project ambidexterity in a turnaround project at the occasion of a plant shutdown. Project ambidexterity was retrieved: different examples indicated the achievement of exploration and exploitation, no inconsistencies were found and some complementarities were found. Hereby (1) *all four categories antecedents of ambidexterity* could be observed (i.e., structural, sequential, contextual and leader-ship based antecedents). Furthermore, (2) *no inconsistencies* and (3) *some complementarities* between the four categories antecedents of ambidexterity were observed. The case study findings clearly demonstrate that it is possible to explain project ambidexterity by considering a combination of the four categories antecedents of ambidexterity. A limited focus that does not consider all categories antecedents of ambidexterity across the different levels of analysis, could overestimate the effect of certain categories antecedents or levels of analysis while the observed project ambidexterity is only partially explained by the pretended relation. Further research is necessary to investigate to which extent the demonstrated usefulness of this approach can be generalized.

Keywords: ambidexterity, project ambidexterity, structural, sequential, contextual and leader-ship based antecedents of ambidexterity

Paper category: case study

I. Introduction

Organizational ambidexterity is the ability of firms to excel at both exploration and exploitation (Tushman & O'Reilly III, 1996; Raisch & Birkinshaw, 2008; Andriopoulos & Lewis, 2010; Nosella, Cantarello, & Filippini, 2012; Birkinshaw & Gupta, 2013; Turner et al., 2013). *Exploration* is the development or search for new knowledge, competencies and capabilities, whereas *exploitation* is all reuse and refinement of previous knowledge, competencies and capabilities (Raisch & Birkinshaw, 2008). Projects are one particular setting where ambidexterity is often required (Maylor et al., 2006; Winter, Andersen et al., 2006; Geraldi et al., 2011; Leybourne, & Sainter, 2012; Liu & Leitner, 2012; Eriksson, 2013; Turner et al., 2015). There are different ways to develop the ability to combine exploration and exploitation. These different ways to achieve the ability are labelled as antecedents of ambidexterity. Strategy literature theorizes that there are *four types of antecedents* for ambidexterity: *structural, sequential, contextual* and *leadership-based* antecedents (Raisch & Birkinshaw, 2008; O'Reilly & Tushman, 2013). Nevertheless, so far research has mainly focused on the general concept of ambidexterity or on one specific type of ambidexterity (Raisch & Birkinshaw, 2008; O'Reilly and Tushman, 2013).

Academics have recently emphasized the need for more holistic research that investigates combinations of antecedents (e.g. Raisch & Birkinshaw, 2008; Raisch, Birkinshaw, Probst, & Tushman, 2009; Andriopoulos and Lewis, 2010; Birkinshaw & Gupta, 2013). E.g., Turner et al. (2013, p. 328) summarize based on their review of 85 empirical ambidexterity papers that “*The conceptions of*

temporal, structural and contextual ambidexterity are well documented, yet the application of such constructs to a multi-level organizational configuration is difficult. (...) Similarly, although the role of managers and management teams has been studied, relatively little has been demonstrated regarding how managers can actually orchestrate exploitation and exploration." They conclude "*Both scholars and practitioners need a more holistic, multi-level, understanding*". (Turner et al., 2013, p. 328)

By means of single case study research we clarify *how* all four antecedents of ambidexterity (structural, sequential, contextual and leadership-based ambidexterity) were associated with the ability to combine exploitation and exploration and achieve *project ambidexterity*. In addition, any inconsistencies or complementarities between different antecedents of ambidexterity and among levels of analysis are described. The case study focused on one turnaround project of a chemical firm (nickname ChemBE). A turnaround (TAR) project entails the entire set of activities, tools, equipment, materials, and personnel that are necessary to plan and perform all required operations during a planned shutdown of an installation. During the investigated TAR2015 project the execution of two innovative and complex capital investments needed to be combined with shutdown work for regular inspection, maintenance and repair (IMR2015). All three were initially prepared by separate teams during the project planning. Subsequently, the three activities were integrated into one planning. Despite optimal exploitation of earlier knowledge and skills, and quite some exploration of new knowledge and skills, the integrated planning was more than 7 weeks. Despite current best practices were applied and quite some exploration had already occurred before, the planned shutdown needed to be reduced to 5 weeks to keep it within cost and time limits. This was eventually achieved by enormous additional exploration. Despite the high level of innovation and new work processes, the actual execution could be executed within safety, quality, time and cost limits.

The case study shows that (1) a combination of structural, sequential, contextual or leadership-based antecedents occurred. (2) These were not just stand-alone phenomena but interrelated practices that jointly create the ambidexterity capability. For instance, the four antecedents of ambidexterity in isolation did contribute to project ambidexterity, but contextual antecedents (at the organizational or project level) and leadership-based antecedents (at the organizational or project level) additionally helped to overcome the typical inertia that impeded behavior switches between or combinations of exploration and exploitation. (3) No inconsistencies between categories of antecedents were found.

Our contributions can be summarized as: (1) the *empirical decomposition* into a combination of *structural, sequential, contextual or leadership-based antecedents* that together contribute to *project ambidexterity* and (2) the description of *interdependency* between types of antecedents. We explained *how* combinations of antecedents types proved important, e.g. contextual and leadership-based antecedents are important to facilitate ambidexterity through structural and sequential antecedents. We thus also provide further empirical evidence that (3) leadership-based antecedents should be definitely considered as a full type of antecedents in future research.

The paper structure contains (I) introduction, (II) literature review and research questions, (III) methodology, (IV) results, (V) case study learnings, (VI) discussion and (VII) conclusions, limitations and directions for future research.

II. Literature review and research questions

II.1. Ambidexterity

Organizational ambidexterity is the ability of firms to excel in both exploration and exploitation (Tushman & O'Reilly III, 1996; Raisch & Birkinshaw, 2008; Andriopoulos & Lewis, 2010; Nosella et al., 2012; Birkinshaw & Gupta, 2013; Turner et al., 2013). Definitions for exploration and exploitation are derived from the organizational learning, strategic management and organization design literatures (Raisch & Birkinshaw, 2008). *Exploitation* is linked with efficiency, control, certainty, refinement, variance reduction, implementation, execution and often has a short-term orientation. We consider reuse and refinement of existing knowledge, competencies and capabilities as exploitation (Raisch & Birkinshaw, 2008). *Exploration* is about innovation, autonomy, search, experimentation, risk-taking, discovery, flexibility, and takes a long-term orientation. We consider the development or search for new knowledge, competencies and capabilities as exploration (Raisch & Birkinshaw, 2008), regardless if it is single or double loop learning. These definitions are similar to the ones Turner et al. (2013, p. 320) deduced from an extensive literature review *"Ambidexterity is the ability to both use and refine existing knowledge (exploitation) while also creating new knowledge to overcome knowledge deficiencies or absences identified within the execution of the work (exploration)."*

II.2. Why being ambidextrous (in projects)?

The main reason companies strive for ambidexterity is its association with firm performance. We refer to the review of O'Reilly, and Tushman (2013, p. 325) that summarizes theoretical papers, case studies, anecdotal evidence and studies using large samples with longitudinal data. They observe a dominant positive association of ambidexterity with sales growth, subjective ratings of performance, market valuation as measured by Tobin's Q and firm survival. Furthermore they refer to positive performance effects of ambidexterity at the firm, business unit, project and individual level, especially in case of environmental uncertainty, increased competitiveness and sufficient organizational resources which is more often the case in larger firms. O'Reilly, and Tushman (2013, p. 326) conclude that *"the results linking ambidexterity to performance are robust, (...) despite using different measures of ambidexterity, a range of outcome variables, different levels of analysis, and samples from differing industries."*

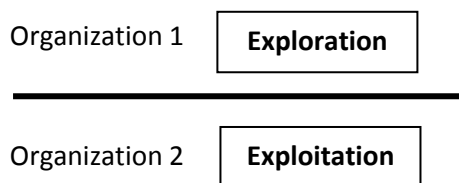
During the last decades project-based management has extended to many sectors (Cicmil, Williams, Thomas, Hodgson, 2006). The need for exploration in addition to exploitation and the performance impact of ambidexterity, raises an increasing attention for **project ambidexterity** in both the project management literature and ambidexterity literature. Projects are a common unit of organizing both exploitation and exploration in contemporary organizations (Maylor et al., 2006; Winter et al., 2006; Geraldi et al., 2011; Liu & Leitner, 2012; Eriksson, 2013; Turner et al., 2015). Projects face unique challenges as well as tight constraints (e.g. scope, time and cost) so exploration is necessary to find solutions for unique problems while exploitation needs to improve efficiency (Liu & Leitner, 2012; Eriksson, 2013). In addition, Leybourne, and Sainter (2012) add other typical challenges such as scope changes, time and cost overruns and changing demographic of project-based workers. They conclude that the ambidextrous demands for modern organizations require to exploit existing and to explore new processes, frameworks, structures... To conclude, ambidexterity in project management is an interesting and growing field of interest (Leybourne & Sainter, 2012).

II.3. How to realize ambidexterity

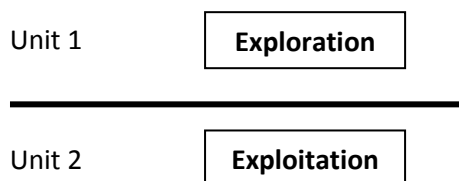
Strategy literature offers a clear overview about the different antecedents of ambidexterity. Antecedents of ambidexterity refer to specific ways to achieve of ambidexterity. Most ambidexterity literature considers one or more out of four widely accepted types of antecedents: inter-organizational, structural, sequential or contextual ambidexterity. Some academics also add a fifth category: leadership-based ambidexterity (Raisch, and Birkinshaw, 2008; O'Reilly and Tushman, 2013). Inter-organizational, structural, sequential, contextual, and leadership-based antecedents are used to achieve ambidexterity. Some literature then labels the ability achieved by means of certain antecedents as respectively inter-organizational, structural, sequential, contextual, and leadership-based ambidexterity.

Figure 4: Antecedents of ambidexterity

Inter-organizational ambidexterity



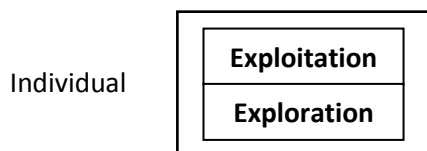
Structural ambidexterity



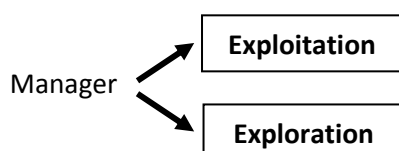
Sequential ambidexterity



Contextual ambidexterity



Leadership-based ambidexterity



Inter-organizational antecedents resolve the tensions between the paradoxical requirements through externalization of either exploitation or exploration (Raisch et al., 2009). Outsourcing or alliances are two examples for the **inter-organizational level** (Raisch and Birkinshaw, 2008; Raisch et al., 2009). The ease to outsource the delivery of products and services and the decrease in communication costs have made ambidexterity at an inter-firm or even community level, instead of a mere intra-firm level, a widespread phenomenon (O'Reilly and Tushman, 2013). O'Reilly, and Tushman (2013) found several studies demonstrating that inter-organizational antecedents can create ambidexterity and this way have positive effects on firm performance. O'Reilly, and Tushman (2013) did not consider inter-organizational antecedents as a separate category. They considered these as structural antecedents in inter-organizational or community settings rather than simply intra-organizational ones. In line we do consider external acquisition of either exploration or exploitation, and internal integration, as a form of structural antecedents. So we will consider four types of antecedents: **structural, sequential, contextual and leadership-based antecedents**.

Structural antecedents rely on the simultaneous pursuit of both exploration and exploitation by structurally separated units that focus on either exploration or exploitation, each having appropriate structures, systems, processes, cultures, incentives etc. which are internally aligned (O'Reilly and Tushman, 2013). The separated explorative or exploitative efforts then need to be integrated by means of integration mechanisms such as a common strategic intent, an overarching set of values, leadership, and targeted linking mechanisms to leverage assets (O'Reilly & Tushman, 2013).

A way to implement structural antecedents at an **organizational level** is through spatial separation that uses separated units with different competencies, systems, incentives, processes and cultures that pursue either exploitation or exploration (O'Reilly and Tushman, 2008; Raisch and Birkinshaw, 2008; O'Reilly and Tushman, 2013). Previous research found complementary relations between inter-organizational and intra-organizational approaches to ambidexterity, and a positive impact of inter-organizational ambidexterity on firm performance (Raisch and Birkinshaw, 2008).

Structural separation is also a possible strategy to achieve **project** ambidexterity. In a production plant, the whole organization can be focused on exploitation while exploration occurs by innovation projects. Another example is a project-based organization (PBO) with structural separation of exploration and exploitation between different subunits (Eriksson, 2013). In a project-based construction company it is, for instance, possible that the manufacturing department exists of project teams that focus on exploitation but a separate R&D department focusing on exploration exists within the own organization (organizational level) or even at an external partner (inter-organizational level). Another example of structural antecedents in a project context is a structural separation at the project portfolio level (project level). It implies that exploration of new knowledge and exploitation of existing knowledge occurs in separate projects (Lavie and Rosenkopf, 2006; Andriopoulos and Lewis, 2009). This is for instance well-described by the distinction between normal projects focused mainly on exploitation, and programs focused on exploration, by Pellegrini et al. (2015). They find by means of a longitudinal case research into a business transformation a complementary use of transformation programs that ensure flexibility while projects ensure the consistent, reliable and efficient delivery of new products, operating changes and key capabilities. A structural separation can also occur **within** one project when different project team members are responsible for either exploration or exploitation.

Sequential or temporary antecedents their initial meaning implies firms realign their structures and processes to changed environmental conditions or strategies (Raisch and Birkinshaw, 2008; O'Reilly and Tushman, 2013) whereby *longer periods* with a main focus on *exploitation* are alternated by a *period of exploration*. The change can be disruptive when the way of working is no longer appropriate.

A disadvantage of such sequential ambidexterity is that the longer periods of exploitation, alternated with short periods of exploration, make organizational members more used to exploitative demands and less focused on explorative needs (Gupta, Smith, & Shalley., 2006, Raisch and Birkinshaw, 2008). Such sequential switching might also be ineffective in case of rapid change (Tushman and O'Reilly III, 1996). Brown and Eisenhardt (1997) introduced a more recent form of sequential ambidexterity, consisting of *temporarily cycling through* periods of exploitation and periods of exploration whereby different formal structures are set up, working in parallel. The parallel structures allow people to subsequently alternate between two (or more) types of structures either focused on exploration or exploitation dependent on the specific task requirements. Usually the formal (primary) structures enable to efficiently execute routine whereas supplementary structures enable the realization of non-routine tasks and innovation (Raisch and Birkinshaw, 2008). Raisch and Birkinshaw (2008) classified ambidexterity created by means of parallel structures as structural antecedents. We do classify these as structural antecedents if different parallel structures are used simultaneously by different structurally separated people to focus on either exploration or exploitation. Nevertheless, we classify parallel structures as sequential antecedents in line with O'Reilly and Tushman (2013) when the same group of people shift over time between parallel structures to focus sequentially on either exploration or exploitation. The main advantage is that switching from time to time between formal structures is far more easy than changing the culture and informal organization (Nickerson and Zenger, 2002; Raisch and Birkinshaw, 2008; Boumgarden, Nickerson, & Zenger, 2012; O'Reilly and Tushman, 2013).

Liu and Leitner (2012) found in a project-context such sequential separation of exploration and exploitation enabled by means of parallel structures. It successfully contributed to project ambidexterity and eventually to project performance (Liu and Leitner, 2012).

Contextual antecedents were introduced by Gibson and Birkinshaw (2004). Contextual antecedents imply a supportive business-unit context that enables and encourages by means of systems, processes, and beliefs individual workers to judge for themselves how to best divide their time between the conflicting demands for exploitation and exploration (Gibson & Birkinshaw, 2004; Raisch & Birkinshaw, 2008; O'Reilly & Tushman, 2013). Gibson and Birkinshaw (2004) empirically prove that contextual antecedents rely on contextual support and have a positive performance impact when **organizations** find a successful balance between hard elements such as discipline and stretch (performance management) and soft elements such as support and trust (social support). One main difference with structural and sequential antecedents is the focus on **individuals** rather than units (O'Reilly and Tushman 2013) and thus on the individual level instead of a group, project, organizational or inter-organizational level. Structural and sequential antecedents imply organizations separate exploration and exploitation by structural separation or by sequencing over time. Contextual antecedents relies on systems, processes or beliefs that encourage *individuals to optimally divide their time between exploitation and exploration* (Gibson and Birkinshaw, 2004). This brings us to a second major difference with the clearly defined structural and sequential antecedents concepts (O'Reilly and Tushman, 2013, p. 329) : “*what the organizational systems and processes are that enable this individual adjustment is never concretely specified, other than that they promote stretch, discipline, and trust.*” Nevertheless, O'Reilly and Tushman (2013) do cite research which describes that management controls and culture can support workers to combine the efficient execution of routine tasks with a continuous search for efficiency improvement, to combine contradictory goals such as flexibility and control or creativity and implementation within one unit.

In projects mostly one team of project members needs to handle both exploration and exploitation requirements. Likewise, contextual antecedents are useful to foster the project members to combine both.

Leadership-based antecedents imply that senior managers foster themselves ambidexterity and also support the implementation of other antecedents of ambidexterity (Raisch and Birkinshaw, 2008). Tushman, and O'Reilly (1996) empirically illustrated that ambidextrous managers must be able to cope with the varied organizational architectures and the multiple cultures. These managers' ability to manage units with varied structures and cultures mostly stems from a relatively long tenure in the organization whereby they have become familiar with the organizational architectures and have become the embodiment of the corporate culture (Tushman & O'Reilly, 1996). This long history in the firm may not impede their willingness to change continuously to meet the future. These managers do not let their organization become arrogant and complacent, but keep everyone humble, modest, and focused on a striving for renewal (Tushman & O'Reilly, 1996).

Birkinshaw and Gupta (2013, p. 290) explain that firms exist to do difficult things, such as making trade-offs between exploration and exploitation and allocation of scarce resources. Hereby they emphasize the specific role of managers: *"To be effective in these difficult tasks, firms require managerial competence; they need managers who can make thoughtful trade-offs between competing demands, and who can find creative solutions that transcend either/or solutions."* In this study we rely on one clear difference between contextual and leadership-based antecedents. Contextual antecedents imply that subordinates individually combine exploration and exploitation themselves. Overall ambidexterity can be explained by these bottom-up efforts for it. Leadership-based antecedents imply that managers stimulate ambidexterity top-down. Managers can for instance foster themselves ambidexterity by focusing their own efforts on optimizing the combination of exploration and exploitation e.g. within a project (project level) or the organization (organizational level). Furthermore, O'Reilly and Tushman (2013) refer to different studies that found ambidextrous organizations need managers who are able to balance the competing pressures of different organizational architectures. So managers can contribute to a successful use of structural and sequential antecedents of ambidexterity. Managers who are capable to lead across organizational boundaries can also contribute to the implementation of inter-organizational antecedents which is necessary considering ambidexterity is more and more achieved at an inter-firm or even community level (inter-organizational level) instead of merely at an intra-firm level (O'Reilly and Tushman, 2013). Firms and their leaders can also promote organizational cultures and identities that contribute to the implementation of different antecedents of ambidexterity (O'Reilly and Tushman, 2013). Managers may, for instance, foster a culture that increases understanding and willingness for the switches peculiar to sequential or contextual antecedents, or for the necessity of integrative efforts in case of structural antecedents.

Nevertheless, O'Reilly and Tushman (2013) conclude that it remains less clear in current literature how senior team and leadership behaviors can overcome contradictory demands of exploration and exploitation. They do refer to some research that discovered higher management needs to balance competing pressures of different organizational architectures, but still notice a lack of research that unravels how leaders actually manage both exploration and exploitation. Both the direct and indirect roles of senior team and necessary leadership behaviors still require more research. Abstract theories about ambidexterity still need to be supplemented with practical insights from qualitative and in-depth studies into how leaders actually manage competing demands and obtain effective resource allocation (O'Reilly and Tushman, 2013).

II.4. Literature gaps

The purpose of the research is to verify (1) if one or more of the four types of antecedents (structural, sequential, contextual and leadership-based antecedents) were present in a case *project ambidexterity occurred*. In addition, (2) any inconsistencies or (3) complementarities between different types of antecedents are described.

To answer the research questions, project ambidexterity needs to be present in the first place. *Project ambidexterity* is identified by determination of exploration, exploitation, and any inconsistencies or complementarities between both. First the concepts exploration and exploitation are defined. Exploitation implies the reuse and refinement of existing knowledge, competences and capabilities which contributes to efficiency. Exploration implies the development or search for new knowledge, competences and capabilities. Inconsistencies are any tensions between exploitation and exploration. Complementarities are any indications that both can mutually reinforce each other.

There has been research about ambidexterity as such without subdivision, or research that considered specific types of antecedents. So far no research has considered all four types of antecedents simultaneously. Academics have recently emphasized that in reality combinations of different types are more appropriate (Raisch & Birkinshaw, 2008; Raisch et al., 2009; Andriopoulos and Lewis, 2010; Birkinshaw & Gupta, 2013) and empirical project research has found such combinations (e.g. Liu & Leitner, 2012). We conclude from literature that it is not yet unraveled if a combination of different types of antecedents occurs in case of ambidexterity in general, or project ambidexterity more specifically. We focus on presence of difference antecedents of ambidexterity.

1. *Does project ambidexterity co-occur with a combination of structural, sequential, contextual and/or leadership-based antecedents?*

Consideration of different types of antecedents, requires consideration of different levels of analysis. Contextual antecedents, for instance, occur at the individual level. However, structural antecedents imply a structural separation between individuals focused on either exploration or exploitation, and so by definition implies a higher level of analysis. An inter-organizational level of analysis is needed to investigate structural antecedents at the inter-organizational level. Literature indicates quite some levels of analysis where ambidexterity can occur: alliance, inter-organizational, group, organizational, business units, projects, team, individual level... (O'Reilly and Tushman, 2013; Birkinshaw and Gupta, 2013). Many researchers (e.g. Raisch et al., 2009; Birkinshaw and Gupta, 2013) suggested future research should cross the levels of analysis. Raisch and Birkinshaw (2008, p. 396–397) for instance emphasizes the necessity to consider multiple levels of analysis because “*choices about how to resolve the tension at one level of analysis are often resolved at the next level down.*”

Turner et al. (2013, p. 321) reviewed 85 empirical ambidexterity papers and categorized the observed management control mechanisms mentioned in each paper according to type of underlying intellectual capital resources and their level of analysis. As *levels of analysis* they noticed the *organization level, group level and the individual level, or a combination of these*. Turner et al. (2013, p. 324) indicate the need for more research that investigates ambidexterity amongst these levels of analysis “*Ambidexterity is not yet fully established as an explicit managerial strategy, and the higher-level concepts in the literature are not sufficient to explain the realities of modern organizations. A knowledge of the mechanisms by which ambidexterity is achieved in such settings is vital to further the understanding of both scholars and practitioners.*” (Turner et al., 2013, p. 324). Still, Turner et al. (2013, p. 323) conclude in their review and research agenda “*In line with Gupta et al. (2006) and Raisch and Birkinshaw (2008), we argue that the lack of multi-level, multi-domain analysis of ambidexterity is*

limiting our understanding of the concept, and this represents an inadequacy within existing theory.”
To consider all four types of antecedents, we need to consider multiple organizational levels as well as the inter-organizational level.

If project ambidexterity co-occurs with different antecedents of ambidexterity, another interesting question concerns the relations between these different antecedents. Literature mostly implicitly conceptualized different types of antecedents as alternative solutions, but interrelations between these antecedents should get more attention (Raisch & Birkinshaw, 2008). Kauppila (2010, p. 284), for instance, highlights that structural antecedents are often necessary but not sufficient for ambidexterity. In his study of a Finnish firm, structural, sequential and contextual antecedents were observed together and he concluded : *“In reality, firms are likely to create ambidexterity through a combination of structural and contextual antecedents and at both organizational and inter-organizational levels, rather than through any single organizational or inter-organizational antecedent alone.”* Liu, and Leitner (2012) found that contextual and sequential antecedents together contributed to ambidexterity. Contextual antecedents could enable the changes required for sequential antecedents. Eriksson (2013) investigated organizational and procurement related aspects of project-based organizations (PBOs) such as construction firms. He concludes that also PBOs need to combine diverse types of antecedents at different organizational levels to effectively manage ambidexterity. He found that structural and sequential antecedents that separate exploration and exploitation activities at business unit, project portfolio, and project levels were *not* sufficient without appropriate integrating mechanisms. However, there is still a lack of research investigating how antecedents of ambidexterity can be combined at different organizational levels in PBOs (Eriksson, 2013).

2. Which inconsistencies occur between different antecedents of ambidexterity?
3. Which complementarities occur between different antecedents of ambidexterity?

We will start with qualitative case study research in one turnaround project with the determination of project ambidexterity (exploration, exploitation, inconsistencies, complementarities). Then we disentangle the different antecedents of ambidexterity (structural, sequential, contextual and leadership-based antecedents) and their interdependence (inconsistencies, complementarities). We focus on four levels of analysis: the inter-organizational, organizational, project and individual level. This conceptual clarity about the applied antecedents of ambidexterity and interdependence of ambidexterity within a project, will be useful for future research that wants to unravel the management control practices used to implement the different antecedents of ambidexterity.

III. Methodology

A complex contemporary phenomenon, managing project ambidexterity, was studied in depth in a real-world context. A case study approach was appropriate because of four reasons (Yin, 2013). (1) The main research question was “how” different antecedents of ambidexterity co-occur. This can indicate that project ambidexterity is created by a combination of different antecedents of ambidexterity. Qualitative research allows to collect the necessary insights. (2) Research was done while the project was still going on. This made it impossible to have a clear overview and to delineate a clear focus upfront. (3) The researcher also had no control over behavioral events considering the investigation focused on the realization of project ambidexterity in a real-life context. This made that other qualitative methods such as experiments could not be used. (4) A holistic approach was necessary to consider four different antecedents of ambidexterity at different managerial levels and to describe

mutual relations. Even within a single case study it was not straightforward to distinguish between different antecedents of ambidexterity and describe interdependencies

The selected case concerned a turnaround project of one production installation (PlantPROD) at the Belgian daughter company ChemBE of a multinational chemical company ChemCO. Turnarounds are required for all production installations at a regular basis to execute regular and recurrent turnaround work existing of Inspection, Maintenance & Repair work (IM&R). At this production installation (PlantPROD) the IM&R work occurred two yearly thus the previous one was during the TAR2013, the current one was the TAR2015 and the next time was the TAR2017. Nevertheless turnarounds require a shutdown of the plant and this standstill is often used for the execution of some capital investment work as well. The selected turnaround at PlantPROD, labelled TAR2015, consisted of the normal IM&R2015-work and two large capital investments. First, a Heat Integration investment (HI) needed to assure energy recuperation from residual heat of the steam released by installation PlantPROD during production. Second, the whole operating system of the firm needed to be replaced after more than 20 years of service due to obsolescence. This replacement of the operating system, the Distributed Control System (DCS), required an extensive preparation because it is the core of the installation, needed to be developed from scratch especially for that plant and any minor mistake could result in breakdowns afterwards. The Turnaround (TAR2015) is the integrated project that exists of the HI, DCS and IM&R2015 work. This case was thus a project within a production installation PlantPROD whereby daily operating personnel of the installation PlantPROD were involved in the turnaround project organization. It differs from a typical multi-project organization where project coworkers their daily work often consists of projects. The advantage is that this operating personnel know the daily operations of the installation. The disadvantage is that installation personnel are in the habit of daily operations and need to adapt to a project organization. Therefore other ChemBE personnel of specialized departments are involved: engineering, scaffolding, TAR managers, TAR schedulers and TAR controllers... IM&R work was prepared by a diverse group of own PlantPROD operating personnel as well as specialists from these specific ChemBE departments. The same goes for the DCS work, whereby PlantPROD its technical automatization people, closely collaborated with other ChemBE specialists and one contractor. The HI work was mainly prepared by the engineering department of ChemBE, in close collaboration with some PlantPROD contact people.

With regard to the case we want to verify some terminology we will use, as shown in table 1.

Table 1 Terminology

ChemBE	Belgian subsidiary of international chemical company ChemCO. ChemBE exists of more than 50 production plants/installations
Installation / PlantPROD	Specific production plant where the turnaround took place
HI	Heat integration project / capital investment 1
DCS	Distributed Control System / capital investment 2
IM&R	Inspection, Maintenance & Repair work / regular and recurrent turnaround work
Turnaround / TAR / TAR2015	Integrated project : HI + DCS + IM&R2015
Shutdown	Period the installation is closed to execute the turnaround work that cannot be done during operations (during the end of the detail planning, complete execution, and beginning of the post-shutdown)
TAR manager	Member of specialized TAR department who leads the turnaround process and the whole TAR management team

TAR controller	Member of specialized TAR department who is responsible for cost control during the turnaround processes
TAR scheduler	Member of specialized TAR department who is responsible for scheduling of all TAR work within one integrated TAR tool
TAR/TMS (planning) tool	Integrated TAR schedule tool : all work activities that need to occur are scheduled serial or parallel during the planning to facilitate an efficient execution afterwards
TAR management team	TAR manager + installation management + capital investment managers + TAR controller + TAR scheduler ...

Rigor case study evidence was collected by a deliberate case study design and data collection that assured construct and internal validity as well as reliability. Data collection comprised direct observation, physical artifacts and scrutinizing documents (e.g., manual, process reports, TAR tool with costs and scheduling). Direct observations and physical artifacts allowed to observe the realized antecedents of ambidexterity at different levels of appearance. Furthermore it allowed to understand the context and to experience the culture. Diverse documents, drafted by diverse people, allowed broad but specific information about the standardized turnaround process and the respective focus on exploration and/or exploitation. After the turnaround 12 extent interviews with core people involved in the TAR2015 were taken. We first explained them the concepts exploration and exploitation. *“Exploitation implies the reuse of past knowledge and capabilities which contributes to efficiency. Exploration implies learning ; the exploration of new knowledge and capabilities contributes to innovation.”* The actual interview started with a broad question : *“Where were exploration and exploitation present in the TAR-project?”* Follow-up questions related to what triggered this exploration or exploitation. In this way, interviewees described what they immediately associated with exploration and/or exploitation. *“Can you give examples of exploration and/or exploitation during the turnaround? What fostered this exploitation or exploration?”* For diverse management control mechanisms that were not mentioned spontaneously after these first questions, it was asked if the management approach *“was used during the TAR-project?”* We thus asked explicitly whether it was used or not, in which stage and how it contributed, hindered or had no effect with regard to exploration and/or exploitation. One follow-up question with regard to management controls was for instance *“does it stimulate exploration and/or exploitation.”* A last broad question handled the appropriateness of the project management. *“Is the used management approach appropriate?”* Here we again questioned the appropriateness. *“Do you see potential improvements? Do you think of some specific aspects that they reinforce or hinder each other while striving for exploration and exploitation? Do you think all management practices are independent?”* These targeted questions allowed to determine 1) the presence of exploration, exploitation and ambidexterity in the TAR2015, 2) which combination of antecedents was observed, and 3) the relations between different antecedents of ambidexterity.

The antecedents of ambidexterity and respective relationships were inducted from the interviews and other data by the researchers. Like this it was not necessary that ChemBE personnel understood the exact meanings of all terms. It allowed to get the necessary insights, explanations as well as personal views with regard to the effective realization of exploration and/or exploitation. A case study protocol was used and all available documents, manual, sound tapes and written down interviews were stored in a case study database to assure co-authors and reviewers to verify the results. We also relied on proofreading and feedback from the interviewees which together assured construct validity. By means of triangulation of data all findings were linked. No contradictory statements were noticed despite the extensive and diverse case study data and active attempts to disprove earlier findings and discover alternative explanations which assured reliable case study learnings and a strong internal validity.

Nevertheless, external validity stays limited considering that a single case study does not allow generalization without confirmation by other studies.

Table 2 Research agenda

a)	March '15 - May '15	Orientation meeting: Preliminary informal contacts and formal meeting with TAR department and site management (11/05/2015)
b)	June '15	Orientation meetings about the TAR: We had a couple of explorative meetings with both TAR department and site management to get broad insights into the capital investments (HI, DCS) and the IMR work that needed to be integrated in the turnaround project. (17/06/2015 ; 25/06/2015)
c)	Aug. '15	Manual: Reading the 20-pages-summary of the standardized turnaround process manual with regard to control processes to discern the package
d)	Aug. '15	Investigation of documents (e.g. TAR scheduling tool, TAR controlling tool, TAR final reports etc.)
e)	Sept. '15	Orientation interviews: Broad interviews (2 hours) with 1 turnaround manager and 1 turnaround controller to discern the used management control package (01/09/2015)
f)	Oct. '15	Semi-structured interview: Interview (3 hours) with 1 turnaround controller about the Bedford and Malmi (2015) questionnaire to discern the package (19/10/2015)
g)	March '15 - May '16	Observation: Observation of the planning, execution and post-shutdown phases of the TAR2015-project
h)	June '16 - Feb. '17	In-depth semi-structured interviews: 12 people are interviewed to get an in-depth insight into the occurrence of ambidexterity, the antecedents and the relations. All interviews were transcribed, coded and analyzed.
i)	June '16 - Feb. '17	Investigation of documents (e.g. TAR scheduling tool, TAR controlling tool, TAR final reports etc.) with regard to this specific turnaround
j)	Nov. '16 - Feb.. '17	Manual: The findings derived from all data are compared to the full standardized turnaround project process prescribed by the manual (300 pages)
k)	March. '15 - Dec. '17	Interviews, meetings, proofreading: TAR department and site management have the possibility to give feedback on the paper to validate causal explanations

Table 3 Interviewed people

Function	Nickname	
Maintenance manager (PlantPROD)	Interviewee 1	I1
Head of the scaffolding department (Scaffolding)	Interviewee 2	I2
Manager production installation (PlantPROD)	Interviewee 3	I3
Headman technical automatization (PlantPROD), also manager leading the DCS capital-investment	Interviewee 4	I4
Head of product group with affiliated installations (three installations among which PlantPROD)	Interviewee 5	I5
Headman production (PlantPROD)	Interviewee 6	I6
Manager HI-investment (Engineering department)	Interviewee 7	I7
TAR controller (TAR department)	Interviewee 8	I8
Headman mechanical work (PlantPROD)	Interviewee 9	I9
TAR manager (TAR department)	Interviewee 10	I10
TAR planner (TAR department)	Interviewee 11	I11
Headman assets (PlantPROD)	Interviewee 12	I12

The case study relied on multiple data sources, performed at different stages in the process, as shown in Table 2. The twelve people interviewed during the in-depth semi-structured interviews and quoted during the results are listed in Table 3.

IV. Results

Project ambidexterity

Each turnaround project needs to fit within **tight safety, quality, time and cost restrictions**. Therefore, earlier acquired knowledge, competencies and capabilities are accumulated for **exploitation** by means of different work tools, specialized departments... The reuse of existing best practices allows to do things at least as efficient as before which is necessary and get the turnaround within the tight restrictions. One can rely for each turnaround on considerable **exploitation** for the normal **IM&R-work**. IM&R requirements, however, do change considering the ageing installations or changing regulations and **exploration** is required as well. Furthermore, **unique capital investments** such as the **HI-investment** and **DCS-investment** can only partly rely on exploitation and require quite some **exploration**. The TAR department has much knowledge and skills with regard to the **integration** of different IM&R-work and the additional capital investments, but again needs quite some **exploration** besides this **exploitation**. So each of the three work teams (IM&R, HI and DCS) as well as the TAR management team responsible for the integration of all planned work, needed to combine the reuse of earlier knowledge, competences and capabilities with the development of new knowledge, competences, and capabilities. So the integrated planning was the result of quite some exploitation and exploration. Despite marking use of available best practices and quite some exploration, an optimal planning took 7 weeks. This was far too long, the shutdown needed to be reduced to 5 weeks to fit in time and cost limits. TAR management stimulated all work teams to excel current best practices and to look for new ways to perform work on the critical path. Also TAR management itself needed to reinvent integration processes. For instance, different types of work that had always been planned serial, were this time planned parallel. It required quite some **additional exploration** to rethink all work activities, work flows etc. The planned shutdown of 7 weeks, after exploitation and exploration, could be reduced by means of additional exploration to 5 weeks and within safety, quality, time and cost restrictions. The final planning sets a new benchmark. Nevertheless, the actual execution of the planned work passed flawlessly. Even different unexpected problems that appeared during the execution, could be tackled successfully. After the shutdown, relevant newly acquired knowledge and capabilities and acquired insights, were saved to reuse later on.

The initial planning process resulted in an integrated turnaround of 7 weeks. This planning reused existing knowledge, competencies and capabilities, and already included quite some new knowledge, competencies and capabilities that were the result of exploration. The reduction to 5 weeks was thus the result of pushing out boundaries. It delivered an appropriate setting to investigate the composition of antecedents that contributed to project ambidexterity. Interesting enough complementarities were found, whereas **no tensions emerged**. The ability to combine exploitation and exploration within a project, without tensions, makes it an interesting case for ambidexterity research.

In the following part, we describe (1) the occurrence of project ambidexterity, (2) we discuss how different antecedents of ambidexterity co-existed, and (3) we describe relationships between these antecedents of ambidexterity across levels of analysis.

Project ambidexterity : exploration, exploitation, and their relatedness

We illustrate the prevalence of project ambidexterity by analysis of the 12 semi-structured in-depth interviews. The processing of the interviews occurred both quantitatively and qualitatively. First, the 12 interviews were verbatim transcribed (over 300 pages), uploaded and analyzed in NVivo. A coding structure was developed with two categories: (1) achievement of exploration, (2) achievement of exploitation. Larger text blocks which pointed to the realization of exploitation and/or exploration were coded accordingly. Frictions or incompatibility between exploration and exploitation, and independence or even complementarity between exploration and exploitation, were unraveled using qualitative analysis of these blocks of text. Qualitative analysis was also used to unravel the different antecedents of ambidexterity and the relatedness between the antecedents. We considered (1) structural, sequential, contextual and/or leadership-based antecedents. In addition, we considered the (2) inconsistencies and (3) complementarities that occurred between different antecedents of ambidexterity. Statements of interviewees that link specific antecedents of ambidexterity to the realization of exploitation and/or exploration were used to write down the findings.

In Table 4 we give an overview of the number of quotes describing the achievement of exploration or exploitation, that were mentioned during the interviews for the different categories of management controls:

Table 4 “Nvivo 1” Exploration and exploitation.

Construct	# interviews	# Quotes
Exploration	12	375
Exploitation	12	921

To describe the results we used the extensive qualitative interview data to understand and describe project ambidexterity, and to unravel the combinations of different antecedents. Examples of exploration, exploitation, and structural, sequential, contextual, and leadership-based antecedents, were used. We first describe the realization of exploration and exploitation during the planning, execution and post-shutdown phases of the TAR2015-project at the ChemBE installation with nickname PlantPROD. When project ambidexterity was described, we described the different antecedents of ambidexterity and their relatedness based on interview data. We consider all four types of antecedents: structural, sequential, leadership-based and contextual antecedents. Furthermore we consider multiple levels of analysis: the inter-organizational, organizational, (turnaround) project (TAR), different work teams (IM&R, HI and DCS), and individual level. Qualitative research does not allow to proof causality between the diverse antecedents of ambidexterity and exploitation and/or exploration. It does allow to describe clearly how interviewees perceived certain phenomena. We provided descriptions based on the detailed manual, observations, meetings, semi-structured interviews and scrutinizing planning preparations, tools and documents with quotes from the interviews to explain as clear as possible how project ambidexterity and different antecedents of ambidexterity were observed. We constantly compared the findings during interviews with all this information. The univocal statements by the diverse interviewees, in line with the observations as well as underlying documentation such as the manual, and the useless efforts to find deviating opinions, made it straightforward to converge the case study results.

In the next section we summarize the examples of exploration, exploitation, their relatedness, the observed antecedents of ambidexterity, the level of analysis they appear, and if applicable the relatedness among antecedents and across levels.

Turnaround department

The TAR department was a specialized department structurally separated from daily installation operations at PlantPROD. During the daily production PlantPROD was mainly focused on exploitation which made most plant employees mainly exploitation-focused. For turnarounds they got guidance from the TAR department that was in the lead to plan and execute turnarounds. The TAR department brought in the specialized expertise, experience and tools to handle a turnaround. They also mastered the turnaround process manual very well, whereas it would require own plant personnel considerable efforts before they knew only the basics. Specialization also enabled the TAR department to exploit lessons learned from other (earlier) turnarounds, e.g. insights or turnaround process innovations gathered during earlier turnarounds of the same plant or at other plants.

There is a structural separation between the TAR department and the different production installations at the firm site. The TAR department is specialized in the guidance of installations at the occasion of turnarounds. The TAR department also combines exploration and exploitation of turnaround processes and these knowledge and skills are then later exploited at other production installations as well. It is an example of structural antecedents at the organizational level. The interruption of daily operations focused on exploitation by TAR projects with a need for exploration and exploitation, is an example of sequential antecedents at the organizational and project level.

Turnaround project

“Every installation needs to shut down every couple of years due to legal inspections, wear and tear, catalyst attrition etc. In this installation, the lifetime of the catalyst determines the period between two shutdowns. A turnaround project concerns these kinds of normal heavy maintenance. Besides the heavy maintenance included in the turnaround project, there are capital investments. The shutdown of a turnaround project requires a standstill which allows to implement other improvements that require a standstill. This turnaround, two capital investments needed to be integrated : the heat integration investment (HI) and the Distributed Control System-investment (DCS). Heat integration is a process improvement that realizes a cost saving because residual heat of steam is captured in a heat exchanger. Waste heat is now used to save energy and thus costs. The DCS was a replacement investment. The distributed control system is the operating system of the whole installation. The previous DCS was more than 20 years old and in the meantime lots of things had changed. Soon the supplier would stop the product support so a replacement was necessary. The new DCS was not a standard product. The hardware and some basic elements of the operating system already existed, but the actual application with the operating system and software that directs the process is installation specific and needed to be developed.” (I1)

This turnaround the standstills of for the DCS (2 weeks work on critical path), HI (4 weeks work on critical path) and IM&R work (normally 2,5-3 weeks work on critical path) were combined; *“The mechanical work for the heat integration investment requires a standstill of the installation . Normal IM&R-work requires two and a half to three weeks.” (I9) “The HI work requires 30 days of mechanical work alone.” (I7) “The return of the HI depends on the energy savings, the cost of the project and the*

*cost of the [extra] duration necessary to execute the capital investment.” (I9) Combination obviously fostered efficiency by utilizing the overlap in duration. The standstill for the HI-work requires only two weeks extra time if it could be fully integrated with the shutdown already necessary for the IM&R-work and now work paths for HI and IM&R work were done serially. In practice both types of work do interfere and quite some work needed to be done serially. Nevertheless, the total planned shutdown could always be shorter than the sum of the respective critical paths. **The integration of IM&R, DCS & IMR-work in one TAR-project is an example of structural antecedents at the TAR level. Different innovative investments as well as normal IM&R work are prepared decentralized but integrated later on to optimize efficiency.***

The TAR project took off with the appointment of a TAR management team. Good leadership by the TAR manager and even the whole TAR management team was considered essential by management to get things done; *“The leader is always important, in fact he is a bit the driving force. He sets the initial targets. It still needs to be feasible, not too short. Otherwise an impossible time pressure will cause errors and money will be lost. But the higher the objectives, the better you will prepare yourself.” (I12) “Managers need to keep on heading everything. Things need constant stimulation. Nothing occurs by itself. And that’s the case for everything. Safety, for example, needs to be constantly stimulated.” (I5) **TAR management sets the initial targets and from this a required level of exploration and exploitation follows. They also stimulate the TAR project team towards the expected targets. It is an illustration of leadership-based antecedents at the TAR project-level.***

The planning phase focused on the elaboration of an extensive, accurate and integrated turnaround planning. Nevertheless, the project planning process is designed to start quite decentralized. Initially there was a *structural separation* between the preparation of the HI capital investments, the DCS-investment, and the repair and maintenance work (IM&R); *“All repair and maintenance as well as little modifications are prepared by the IM&R team that consists of installation’s maintenance co-workers supplemented with people of the TAR department. Once larger modifications need to be prepared, the project engineering department gets involved which has an own approach to prepare capital investments. Then the engineering team discusses the work preparations with the installation and for instance takes the lead in work that can be done before the shutdown. (I8) Both HI and DCS are examples of structural antecedents. We notice special separation between a capital investment that requires considerable exploration besides the exploitative efforts on the one hand, and inspection, maintenance and repair work that requires considerably more exploitation than exploration on the other hand. **The decentralization between HI, DCS and IM&R work that each have a specific need for ambidexterity, implies structural antecedents at the TAR project-level.***

The selection of experienced and senior people is then important for complex atypical engineering work because it requires considerable exploration and exploitation ; *“If a big and unique investment occurs, one should compose a team including the most experienced senior people. I do not think you can solve the work requirements by formalization and standardized processes. Often similar investments took place too long ago, things changed, the current investment requires a different approach... so it is very difficult.” (I7) **The reliance on experienced people who need to combine exploitation and exploration themselves within the HI, DCS and IM&R team, implies contextual antecedents at the individual level.***

The heat integration investment was largely prepared by the engineering department that had some points of contact within the production installation. The DCS-investment was also prepared by a specific team. But the DCS-team consisted mainly of installation personnel, assisted by specialized departments but also an external software and service provider, and also other installation production staff was involved from time to time. So despite the engineering team, most plant personnel was to

some degree involved in the preparation of the DCS-work. The IM&R team consisted mainly of installation personnel, again assisted by specialized departments such as scaffolding, rotating machinery, isolation etc. and of course the specialized TAR department which organizes the work in the TAR tool. Nevertheless, the TAR department is not planning the actual work; *“we [TAR department] are not involved how different teams prepared the work more specifically (during the planning).” (I8)* The integrated TAR-project is the term we use for the overall project that contains all different work preparations, the integration into one integrated TAR-project, the execution of this TAR-project and the eventual post-shutdown evaluation. **Again the integration of decentralized IM&R, HI and DCS work with specific ambidexterity requirements in one TAR project where all three are combined for safety and efficiency reasons, is an example of structural antecedents at the TAR level.**

All three teams started to elaborate a planning for their tasks. While the planning phase was progressing the TAR management team existing of core members of the IM&R, HI and DCS teams, and of diverse specialized departments, were united during TAR meetings. The TAR department delivered a TAR manager who got assistance of a TAR controller and under their leadership different planning preparations were integrated into one integrated project plan. **It again illustrates leadership-based antecedents at the TAR-project level.**

Besides these formal TAR meetings, a lot of informal communication between all TAR management team members took place. During this integration process was noticed that an optimal planning initially resulted in 7 weeks of shutdown. This was far too long and additional exploration and exploitation occurred whereby TAR management involved different core people as well as independent specialists to trigger the current best practices. Additional exploitation and exploration eventually led after quite some efforts to a planned shutdown of 5 weeks. This illustrated very well the demanding integration process : ambidexterity allowed to bring a realistic shutdown of 7 weeks, based on current best practices, back to 5 weeks. The planning integration and reduced planned shutdown demonstrated considerable planning inconsistencies and to overcome these additional exploration and exploitation were required. By the end of the planning phase the extensive, accurate and integrated turnaround planning was ready. It included a complete description of any job that needed to be executed during the execution phase, as well as a description of any requirements (e.g. with regard to safety) that needed to be considered while carrying out the mechanical work.

Turnaround project : Planning

DECENTRALIZATION

Capital investments and IM&R work require both exploration and exploitation. The planning phase is most appropriate to combine exploitation and exploration considering the less strict requirements allow innovation ; *“During the planning phase the restrictions are not yet pressing which allows the team members to prepare the planning in a relaxed atmosphere. You really need to give the people the time to prepare, to discuss and to synchronize things they cannot plan on their own. During the planning one does have some time to consider such exercises.” (I5)* **The early preparation of innovative work before the execution starts, is an example of sequential antecedents at the TAR-project level.**

Different interviewees argued why decentralization contributes to exploration and/or exploitation. Structural separation allowed the specialized teams some autonomy with respect to the preparation of the planning of their respective work. This was perceived valuable for the achievement of ambidexterity by different teams as well as by the TAR manager. **It illustrates contextual antecedents within the HI, DCS & IM&R-teams at the project level.**

"Innovation is not that simple that it can be done on command. You need to give some space for innovation." (I8) At one moment you need to assemble people and give them some space with the intention to innovate. (I8)

That freedom needs to be there. Specialization results in both efficiency and innovation. (I3)

A turnaround process is a bit like Formula 1. When you want to improve the car, it needs to be done between two races. Then you do have an own test circuit and if it does not succeeds today you can try tomorrow considering the deadline is only the next race. Once a race is going on and there is a pit stop, such an improvements are beyond question considering you only have 5 to 8 seconds. So a pit stop requires a totally different mentality. Turnaround people focus on a shutdown and have this pit stop mentality. Even during the planning phase where turnaround work planners have no strict time restrictions, they already try to limit the duration necessary for each task considering that the work they are planning needs to be executed during a shutdown later on within strict time limits. Engineering people do not face such strict time constraints during daily work. This makes them less focused on time but allows a more innovation oriented mentality. (I1)

Decentralization is necessary because the nature of work differs. Engineering people are only focused on the capital investments, all necessary engineering, materials and other preparations, but they do not consider other work. TAR people consider the whole and integrate to ensure an efficient shutdown. (I1)

After the headquarters approved the heat integration investment, a team from the engineering department got quite some autonomy to prepare the work. Certain restrictions (e.g. cost and time) were installed. *"The idea for the HI-investment was initialized by an installation co-worker. Process people of the installation subsequently investigated the feasibility and return. After this internal study, an in-depth study is done by process engineers at the headquarters. A commission at the headquarters evaluates the feasibility and return and only in case the return is assured, a capital investment is started. This higher authority is thus external to the installation. Also the TAR department is not involved in the preparation of the capital investments. The TAR department is in fact hired to guide the turnaround preparation and execution."* (I9) **This implies that structural antecedents occurred at the TAR project level** whereby a HI- team of the engineering department and some contacts at the installation realized ambidexterity during the planning while normal operations at the installation could remain focused on exploitation ; *"As heat integration manager I do get task objectives and against what time it needs to be ready, but I am free to decide how and when I will prepare. I just need to assure it gets done in time. So we do get some directives, but I still have the feeling that I get quite some autonomy as long as the required preparations are ready within time. (I7) The freedom illustrates contextual antecedents within HI, or DCS or IM&R teams at the TAR-project and individual level.*

TAR management was considered as an essential aspect for the successful turnaround; *"Project leadership is essential so the selection of a project manager is very important. Good turnaround project performance often depends on the right turnaround manager and project failures occur more when a turnaround manager is not well selected. So we do notice large differences and that's not only the case for this turnaround, but for all turnarounds I know : if the leader is not the right person, a lot can go wrong very quick."* (I5) *"Those turnarounds where a turnaround manager finds the right balance/combination between exploration and exploitation, have probably the highest success rates. If a turnaround manager does not find that balance/combination, it will be very difficult for the other team members to correct."* (I5) **It again illustrates leadership-based antecedents at the project level.**

This turnaround was led by an experienced TAR manager which was perceived highly influential : *"The fact that this specific TAR manager was in the lead, considerably contributed to project success."* (I5)

"It's more efficient to give the lead to a TAR manager because he is more experienced in the management of turnaround projects. The installation manager's knowledge and experience is mainly to optimize the daily operations of the installation which is often not the right background to manage a turnaround. So it is more effective and efficient to assign the lead to a TAR manager and to assure input of information from the installation personnel." (I8) **The leader is thus temporary replaced : not the daily installation manager who is mainly exploitation focused stays in the lead, but a TAR manager who is better able to combine the required exploitation and exploration during a TAR project. Leadership-based and sequential antecedents are thus combined at project level.**

Managers had a direct as well as indirect effect by their own behavior. *"You do have something what I call norms displayed by the chief. These are not norms hung up in the hallway. You do not need to hang them up, you need to show them as chief. With this I mean you can tell a lot but you need to do it yourself at a certain moment."* (I8) Subordinates effectively became influenced by organizational and project management's attention as indicated by the headman assets ; *"There are quite some policies and procedures implemented top-down. Leadership does have an impact. Some things become part of the culture because they get emphasized time and again. Every week, every day even, and during every weekly meeting even extra. So you become part of a culture that displays certain values and where themes recur regularly. For instance the last ten years there is a huge top-down focus on safety that is picked up and spread amongst all site personnel. That focus starts with ChemBE's CEO who broaches productivity and safety during each meeting or other contact. Producing safely is as a result felt strongly about."* (I12) **The ability of site management to foster individuals for certain values (e.g. with regard to exploration and exploitation) across levels illustrates how leadership-based antecedents (at organizational, TAR level or project levels) are linked with contextual antecedents at the project or individual level.**

The heat integration manager indicated that besides the top-down discipline, higher ranked turnaround management also offered some additional impact within ChemBE. when necessary ; *"That the TAR department leads the turnaround organization had two main advantages for the HI work. First of all TAR management gives your capital investments focus and priority. The importance of turnaround projects is widely shared within the company and if a capital investment is part of a turnaround everyone understands its importance. The management focus in a turnaround-related capital investment also forces to communicate immediately and transparently. The TAR department arranges regular meetings during which promises are made and progress is strictly followed up. And if something needs to happen, TAR management has much more influence than me as a capital investment manager to get things done. Secondly the TAR department succeeds to decrease variation by adding structure, a strict process, more supervision... The planning of the HI investment is still our task, but the guidance by the TAR department assured a reduced uncertainty later on during the execution."* (I7)

TAR management themselves mainly contribute to exploitation, and need to allow/support decentralization to allow exploration ; *"Leadership is essential for efficiency. Leaders need to take decisions, motivate and support the team... But when it comes to innovation they do not have a leading role but a supporting role. Anyone can have an innovative idea which can be quite out of the box. But if a conservative manager then discourages, it will not work. Leaders need to support people their innovative ideas as long as relevant."* (I2) So a turnaround manager needs to strive for exploitation while stimulating and allowing exploration within some limits. **Leadership-based antecedents at project level and contextual antecedents at the project or individual level are thus complementary to get HI, DCS and IM&R-work done.**

Essential characteristics for a good TAR manager were also discussed. For instance the leadership capabilities and experience of the TAR manager were indicated as essential for a successful

turnaround; “A turnaround manager needs to be efficiency minded and possess the maturity, expertise and the necessary leadership skills to challenge things while still allowing openness. We do not look for a turnaround manager who is innovative himself. It is more important that a turnaround manager contributes to exploitation than exploration. But he needs to allow both exploitation and exploration and integrate them well. Leadership is very important for that integration of exploitation and exploration. A turnaround manager that only considers exploration will not finish the preparations in time because he keeps exploring. At some point a turnaround manager needs to limit exploration. Not everything can be renovated during one turnaround, innovation needs to be done step by step. The turnaround manager needs to decide which innovative steps to take this turnaround, and which ones the next time. So if a turnaround manager does not consider exploitation, the turnaround project will fail due to a lacking efficiency. By contrary, exploration is very difficult if a turnaround manager only considers exploitation and does not allow any openness for exploration.” (I5) Nevertheless, the turnaround manager did not need to be an expert in all functional domains which clearly illustrated the indirect effects; “One turnaround manager can manage and challenge diverse things without having in-depth technical knowledge. He can for instance direct attention of other experts who do have in-depth knowledge.” (I8) **Again leadership-based antecedents are indicated essential to allow or even stimulate individual subordinates for timely switching between exploration or exploitation and integration of decentralized efforts. Leadership-based antecedents at project level are like this combined with structural, sequential and contextual antecedents.**

A strong cultural tendency was observed towards ambidexterity (contextual antecedents at individual level) ; “If a turnaround manager would not allow exploration, this would be incompatible with the corporate culture. Our culture fosters innovativeness and if employees do not get this chance to think along, they feel curtailed and the common drive disappears.” (I5) “We do have a corporate culture that allows innovation. A good team fosters innovation by its openness and mutual trust.” (I5)

All interviewees mentioned this ability and willingness they had during the planning phase to choose within some limits for a combination of exploitation and exploration of which they thought it was in the project’s best interest. **It clearly illustrates contextual antecedents at the project and individual level.** “You know that if you bring together a group with a clear objective, an explicit mission, and you leave them the time and space and you communicate clearly about the intentions, some good results will arise from it. At least that is what we perceive in this company.” (I8) The shared values, norms and beliefs allowed to leave considerable autonomy during the planning while relying on social control. Interviewees mentioned the **importance of the TAR unit (leadership-based antecedents at project level) to create this contextual antecedents** which brought about the necessary mindset at every time of the turnaround process. Contextual antecedents also stimulated employees to combine exploration and exploitation during the planning, and prepare the actual turnaround execution accurately ; “Everything was prepared accurately and tested extensively. This is because everyone is aware of the importance of good planning and that all different preparatory turnaround work needs to be done. This awareness needs to be stimulated to assure a successful turnaround. Our firm dissociates itself from other firms by these extensive efforts during the planning.”(I5) **Contextual antecedents at the individual level during the planning thus also stimulates the sequential antecedents at the TAR level.**

The involvement and discussion of the new distributed control system was a good example of contextual antecedents. The replacement of the DCS would have a large impact on many installation production staff their daily work. Their commitment was considered necessary for a successful innovative capital investment and a long preparatory process was used to create this commitment. Each production team was asked to delegate one team member who participated in the DCS-team and was involved in the preparation whereby both exploration and exploitation were necessary. The

prepared new distributed control system was afterwards also discussed in each production team to involve all production staff who would need to work with it and consider their concerns and experience timely. *“Not everyone gets what he wants because you need to reach a consensus. But at least you have the cooperation and commitment of everyone. They could even try it out in advance at a test model. Without guiding anything real, they could try out the DCS. This way the abstinence disappeared.”* (I6)

An extent planning allowed to collect all necessary scope timely and to combine exploration and exploitation while elaborating the required work preparations. Early scope collection was also necessary to avoid late scope changes requiring additional exploration and exploitation later on during the planning or execution. Late scope changes would require considerable changes with a huge cost impact ; *“Large changes need to occur timely during the planning process. One must really try this as fast as possible. That’s also the main concern of the TAR department : assuring a timely scope collection and scope freeze. Afterwards you need to plan everything as time- and cost efficient as possible.”* (I12) **Here we notice how even within the planning of projects most exploration needs to occur in the beginning and afterwards the focus is increasingly on exploitation. It illustrates again the sequential antecedents at the project level.**

Planning milestones and the eventual planning allowed to follow up actual progress relative to intended progress of respectively planning process and turnaround execution ; *“No matter which project or activity and at which company, you first need a clear scope. Subsequently you can prepare while you assure it stays within a certain trajectory. You just make a good plan and afterwards you can follow up the progress. This way you always know for sure what you are doing and how you are progressing. If something still goes wrong, you also know where it goes wrong.”* (I2)

INTEGRATION

We thus noticed that exploration and exploitation were combined during the **planning phase**. But whereas the focus on exploration decreased over time, the focus on exploitation increased. Simultaneously, the amount of integration is increasing. This timely integration was indicated as key ; *“Most turnaround project failures are due to a lacking integration of the capital investments in the turnaround projects.”* (I5) So despite optimal combinations of exploration and exploitation were fostered by giving certain autonomy to structurally separated teams (**contextual antecedents within HI, DCS and IM&R teams at the project level**), eventually all work preparations needed to be integrated into one full planning; *“Planning efforts need to be optimally integrated in time.”* (I3) This integration is the TAR department’s responsibility; *“During the planning there are different teams and each team has its own tasks, but eventually it must fit together. So it needs to come together by means of one single turnaround planner and his team led by the TAR manager who need to unite it into an integrated planning.”* (I12) *“The TAR department needs to get the different planning provided by the teams [IM&R, HI and DCS]. The integration is the job of the TAR unit’s people and they also bring together everything in the TAR tool.”* (I8) **Again we notice leadership-based antecedents at the TAR level.** The TAR planner indicated how he in collaboration with the TAR manager needed to trigger all teams to timely deliver their planning preparations (**leadership-based antecedents at TAR project level**); *“It’s the task of the TAR department to direct everything. People will not bring everything by themselves, you need to stimulate them.”* (I11) *“We [TAR management] want to take up our responsibility and use our impact at a very high management level, till even CEO level, to stimulate everyone for a timely integration into the turnaround project of inspection, maintenance and repair work as well as capital investments and warn that insufficient integration causes turnaround failures.”* (I5) The integration was also fostered by the regular TAR meetings with the TAR management team, as well as many formal and informal contacts in between that stimulate integration of exploration and

exploitation efforts by different teams (**structural antecedents at TAR level**) and commitment of all individuals to contribute to the integration process (**contextual antecedents at the individual level**) ; *“One needs communication between teams in diverse meetings. Then one can bring schedules together, discuss certain points and search for solutions. Different people who have expertise are involved and it reinforces each one’s ownership.” (I10)* So during the planning integration both **leadership-based antecedents at TAR project level as well as contextual antecedents at project or individual level were important** ; *“Top management [leadership antecedents] stimulates the timely integration which is also very embedded in the turnaround environment [contextual antecedents]. TAR management is more or less trained for it.” (I5)* The TAR manager himself also emphasized the important role he had during progress meetings where this integration occurred. *“Progress meetings need to occur according to certain rules. We for instance had to combine capital investments and that requires strict processes. And I, as a TAR manager, get from the group the lead in this. I do experience it like that. And those people do expect from me to take the lead and that I stay within that process. I may not abuse it.” (I10)*

Integration required quite some exploration and exploitation considering it was demanding to integrate the IM&R work and two large and unique capital investments into the limited turnaround shutdown window without too high risks for time overrun. One example of optimization was that further exploration and exploitation could reduce the necessary mechanical work for the HIP from 35 to 30 days; *“The planned number of days necessary for the HI implementation could be shortened from 35 to 30 days.” (I7)* This extensive time reduction required a considerable challenge process as well as ambidextrous solutions to get the planned shutdown within the required shutdown window. If we asked how this was triggered **again leadership-based antecedents at TAR-project level and contextual antecedents at the project or individual level were mentioned** ; *“By involving anyone who can bring expertise. And by reinforcement of each one’s ownership and the creation of commitment! Assuring a shared feeling of responsibility amongst these people, our expectations and the feasibility. There is a broadly shared spirit amongst people which we also stimulate, to distinguish themselves by making a difference. But they are aware that they cannot achieve things alone and collaboration is necessary. (I8)*

By the end of the planning phase an extensive, accurate and integrated turnaround planning was available for the installation turnaround; *“IM&R work and capital investment planning are timely integrated into one whole (turnaround project). The TAR tool assures all different maintenance and project work is in one integrated planning.” (I8)*

Summary planning process

The structurally separated IM&R-team, HI-team, and DCS-team (**structural antecedents at project level**) and the integrated TAR project got stimulated by an environment (**contextual antecedents at project and individual level**) and managerial focus (leadership antecedents at TAR project level) to focus on both exploitation and exploration. TAR management actively triggered all involved employees to combine exploitation with exploration if appropriate. They also watched conscientiously if the planning process progressed as prescribed by the TAR manual. By questioning progress as well as results and leading meetings where separate planning efforts were integrated into one single planning tool, managers forced everyone to unite exploitation and exploration planning efforts by the end of the planning. Commitment by individuals was also often mentioned essential for (contextual) antecedents. Furthermore leadership-based and contextual antecedents enabled **structural and sequential antecedents** because the corporate culture fostered some awareness among individuals for the ambidextrous requirements and ensured that project members were aware of the necessity and prepared to switch between the different phases, requirements and respective structures of the

standardized TAR process. Towards the end of the planning phase preparations got more centralized to end up in one integrated planning that allows an efficient execution. As one manager said “it is like preparing a pit stop”.

Turnaround project : Execution

Because the limited own staff, (sub)contractors were hired to do most of the mechanical work during the execution. The outsourcing of mechanical work that relied largely on exploitation and not on exploration, implied no ambidexterity of mechanics considering both were not combined at that moment. These mechanics – mainly contractors - who need to act in compliance with the planning, face a strict bureaucracy with very little autonomy where exploitation is stimulated.

All contractors were triggered by means of a “safety café” to go through the planning and prepare themselves before the actual execution started ; *“Some improvement proposed two years ago and tried a first time last year, was an informal “safety café” some months before the actual execution started. This turnaround was the second time we used it. Each contractor got the work packages that they needed to prepare quite some time in advance. During the safety café they needed to present one by one in a quite official setting with all other contractors what their tasks included, how they would execute them and which safety issues they needed to take care of. Contractors did not want to blunder majorly in front of their competitors which forced them to elaborate their work planning in advance whereas sometimes contractors arrived unprepared in the past.” (I8)*

Just before the execution all mechanical blue collar workers who needed to execute the turnaround exactly as planned, got their necessary training programs, presentations etc. In fact they just needed to deliver safe, qualitative and time and cost efficient work so were focused on exploitation and not on exploration. Mechanical work forces did not need ambidexterity.

By the end of the planning the senior managers themselves stimulated a shift in mindset of involved personnel to focus almost exclusively on exploitation during the execution of the prepared TAR planning. **Leadership-based antecedents at the TAR-project level thus are combined with sequential and structural antecedents at the TAR-project level.** About the moment the shutdown starts a manager said *“you are the bus driver that assures everyone gets on the bus in time [planning is done in time] and then you push the gas pedal and accelerate”*. This quote proverbially describes the transition initiated by management (leadership-based antecedents) from an enabling to a coercive approach, and like this from a combination of exploitation and exploration to mainly exploitation. During the execution a clear structural separation was noticed between the large workforce that carried out the planned mechanical work on the one hand, and the TAR management and the crash team that followed up the project progressed as planned and handled planning deviations or discovery scope on the other hand (structural antecedents at TAR-project level).

The bulk of the work consisted thus of the mere execution of the previously planned work that needed to be executed exactly as planned. The TAR tool assured that one integrated planning tool allowed a smooth collaboration and clear overview ; *“The TAR tool assures all different maintenance and project work is in one integrated planning. The moment an execution starts, we know exactly who needs to do what at what time. It also enables the overview. So during the execution we do have an integrated overriding organization to enable work execution and supervision.” (I8)* *“During the execution the freedom of one person can cause limitations for someone else. Therefore the execution needs to be very strict. It is not acceptable that someone deviates from the plan. What must happen is defined in the TAR tool and there is no autonomy with regard to planned work.” (I5)* *“The objective is to execute*

a sequence of jobs as efficient as possible. And if you then all of a sudden do things differently, you often have a much higher impact than expected. That's why I do think it's not possible to change things. You are not looking for renewing ideas anymore. In case of renewing ideas you can do them a next turnaround but better not the upcoming turnaround. Because then you are shifting the planning which makes everything complicated." (I12) **It illustrates the sequential antecedents at TAR-project level.**

The TAR manager emphasized the importance of strict supervision during the work execution; *"During the shutdown I impose discipline as TAR manager and I do use my hierarchical position. But still in a well-considered way. For instance by showing and communicating very clear all rules in advance and considering any remarks about them. But afterwards I clearly pose that the rules are indisputable and everyone must work according to these rules. And I do make sure everything occurs according to these rules."* (I10) **So leadership-based antecedents at TAR-project level are linked with sequential antecedents at TAR-project level.**

Supervision was as far as possible appealed to own company staff who also needed to change their ambidextrous planning mindset to focus almost exclusively on exploitation. It was also acknowledged by one of the involved headmen that a constant top-down stimulation was experienced as stimulation to behave as expected; *"During the execution not only TAR management but all own personnel guard safety etc., and even supervise compliance among contractors. I do think you are stimulated in all aspects : safety, costs, innovation... and that stimulation occurs at each level. All employees get involved so eventually everyone is motivating each other a little bit."* (I4)

The TAR management follows up the work progress in a centralized way, focused on exploitation by shared values and commitment (contextual antecedents) as well as management focus (leadership antecedents). There was daily follow up by TAR management of actual work progress versus predicted work progress which was highly useful during the execution where management monitors all deviations from the preset planning objectives. Lower level managers and all teams of mechanics acted according to the planning and a high compliance was obtained; *"The TAR tool gives an accessible overview of the whole, and ensures the diverse services are aware of each other's activities. The system allows to control that tasks are only started when preliminary tasks are fulfilled"* (I4)

So an extensive, accurate and integrated turnaround planning needed to be followed exactly. The main focus was clearly **exploitation**. **Deviations** from the planning were immediately highlighted by the planning system but besides compliance was also discussed at a structurally separated daily TAR meeting where TAR management interacted with diverse top and lower managers. Compliance was then discussed interactively which further stimulated exploitation. In case of **issues** these ones were interactively discussed during the daily TAR meeting and management thereby encouraged adequate exploitation and exploration to tackle the problems. **There were thus leadership-based antecedents at the project level during the execution ; TAR management themselves directly combined exploration and exploitation or indirectly stimulated this combination.**

The TAR management team thus discussed deviations from the planning, discovery scope or other unplanned aspects at the TAR project level. This separation allowed that almost the whole organization could stay focused on exploitation while the TAR management team did the additional exploitation and exploration efforts to adjust the planning. **It illustrates the structural antecedents at the TAR-project level.** One main issue occurred during the execution. A main axle that drove some essential installation elements, was disapproved during regular inspection. No spare parts were available considering it was an axle made to measure, and it would take weeks of standstill before the axle could be delivered. Immediately the issue got constant monitoring of TAR management and even organization management of both the Belgian subsidiary ChemBE as the headquarters of ChemCO

considering enormous losses appeared to be likely. Leadership-based stimuli triggered the immediate involvement of internal specialized departments. Nevertheless, they could not verify if the disapproval of the axle was correct. Even the headquarters' specialists were unable to verify the disapproval. Eventually one got in touch via top managers networks with a foreign specialized firm that executes similar tests for the aeronautical industry instead of the chemical industry. **These are leadership-based antecedents at the inter-organizational level to utilize structural antecedents at the inter-organizational level.** While a second opinion by this firm was awaited, TAR and ChemBE organizational management contributed themselves and triggered others to consider all exploration and exploitation that could possibly reduce the standstill. When the situation was saved by the second opinion that demonstrated an inappropriate testing procedure at the first testing firm, the extended standstill would already have been reduced from multiple weeks to a couple of days illustrating the effective ambidexterity. The problems with the axle discovered during the execution illustrated very well how senior managers' dedication can act as a lever for problem solving. While they were forcing the whole turnaround organization to focus on exploitation and to efficiently execute the planning, they were combining themselves exploitation and exploration efforts to adequately manage the urgent problems. Once additional or changed work was adjusted in the planning and discussed with the supervisors, the executive workforce could continue working with the changed planning. In case a demanding additional job needed to be done, a special crash team was appointed upfront that was trusted and got some autonomy. *"There is some autonomy necessary when discovery scope needs to be solved. If certain things appear to be broken, decisions need to be made how to fix it. Then some autonomy is necessary to allow an efficient solution."* (15) The TAR management team (**leadership-based antecedents at project level**) considered ambidextrous solutions and the crash team executed these or solved minor issues themselves by combining exploration and exploitation (**contextual antecedents at individual level**). Who needed to handle discovery scope got thus more autonomy and faced a less strict but more enabling environment where both exploitation and exploration could be combined.

These structural antecedents whereby almost all employees focused on an efficient execution of the planning and the only ambidexterity occurred at the level of the limited TAR management team or crash team triggered by leadership-based and contextual antecedents respectively, proved to be a very effective way to enable ambidexterity during the execution.

Turnaround project : Post-shutdown

Post-shutdown contractors' mechanical staff left and ChemBE's own mechanical staff and management returned towards their daily operations. Nevertheless, TAR management collected during informal talks some lessons learned or ideas to exploit or explore during upcoming turnaround or capital investments. People who could not be reached in person, were asked to deliver their contributions during a survey. The individuals shared their knowledge and capabilities acquired during these IM&R and capital investments, as well as about integration of all work into one turnaround planning and the consequent execution. This general example illustrates leadership-based antecedents at TAR level whereby management triggered others towards exploration and exploitation. Subsequently TAR management brought together all principal people involved during several post-shutdown lessons learned meetings were they actively triggered them to come up with lessons learned and ideas. Besides leadership-based antecedents could also be observed that the staff united during post-shutdown lessons learned meetings were autonomously motivated to contribute to future exploitation or exploration by a supportive atmosphere as well as cultural norms and values triggering

both (contextual antecedents at individual level). They did not need any financial incentives but autonomously came up with their contributions.

Knowledge and capabilities acquired during this turnaround were captured to exploit during future projects. Knowledge and capabilities that were lacking and needed to be explored or other ideas for installation or TAR process improvements were also triggered. Not only current knowledge and capabilities were adjusted (single loop learning) but the whole TAR processes (e.g. with regard to capital investments, integration etc.) were questioned actively (double loop learning). Collection of specific knowledge, capabilities and ideas used to optimize current work practices was mostly single loop learning. Besides we noticed that certain knowledge, capabilities and ideas concerned the overall processes with regard to IM&R and capital investment work or the integrated TAR projects and this was double loop learning. For instance one mentioned that the whole process with respect to the project planning and integration of capital projects could be improved which is double loop learning. The observed combination of single loop learning and double loop learning is interesting for future research.

Examples of lessons learned concern the identification of project activities that had been effectively executed as planned and these successful planning elements could be stored in the library of the planning tool, to be reused (as a standard) in future turnaround projects. Planning activities that had not been successful were discussed with the objective to identify lessons learned to improve future (strategic and operational) planning performance and the future planning process. Cost data and time records were processed and any deviations were discussed to enable future budgeting and scheduling.

The HI-manager (I7) compared the TAR processes with own engineering department processes and emphasized the advantages of this post-shutdown lessons learned process for exploitation and exploration during turnaround projects ; *“It is difficult to document lessons learned and reuse them later in case of big and complex capital investment projects. Nevertheless, I do think we can standardize and document for most of the engineering projects and also learn by incremental improvement. We need to learn as engineering organization to execute some types of projects that often recur better. Only in case of difficult atypical capital investments that only occur seldom may remain some troubles.”* (I7)

Turnaround project : cycling between phases (sequential antecedents at TAR level)

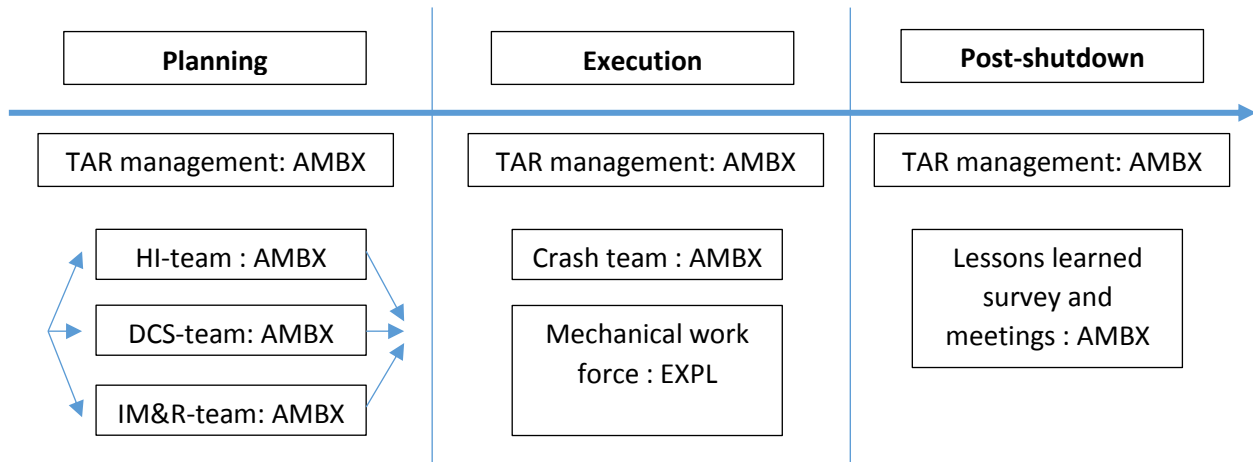
Sequential antecedents were an important element for the observed project ambidexterity. The three turnaround phases – planning, execution and post-shutdown – were clear examples of temporal cycling whereby the respective focus on exploration and/or exploitation changed. During the planning as well as the post-shutdown, both exploitation and exploration got considerable attention. The TAR manager mentioned for instance that much exploration can only be implemented from the beginning on. *“We work flexibly and we want to keep it like that. So we do use a standardized turnaround process, but still offer some flexibility within certain limits. Flexibility has its time and place during the planning process. After the planning it is done with being flexible.”*(I10) The execution was mainly exploitation-focused. Only in case of unexpected discovery scope or other scope, the TAR management team needed to combine exploration and exploitation to tackle these problems. Post-shutdown again both exploration and exploitation got attention.

The temporary cycling from a focus during planning on combining exploitation and exploration to focusing mainly on exploitation during execution to again a combination of exploitation and exploration post-shutdown was accompanied by an alternation between parallel planning, execution

and post-shutdown structures which were part of the standardized turnaround processes (sequential antecedents at TAR-project level). However, the planning phase of the turnaround project (>18 months) was much longer than the execution phase (5 weeks). The post-shutdown initiatives were even shorter. Hence, the TAR project members, involved from the start, were most of the time required to combine exploitation and exploration (planning stage) and only focused during a short period (execution phase) exclusively on exploitation. Nevertheless, for most operating staff involved in the TAR preparation, this work needed to be done while doing their daily operational work as well. They thus were part from an installation or specialized department, which mainly focused on exploitation. Only a small part of their work was the preparation of the turnaround that required ambidexterity. Leadership-based antecedents at the organizational or project level and contextual antecedents at the project or individual level enabled the implementation (separation, integration and switching) of sequential antecedents (at TAR-project level) and structural antecedents (at TAR-project level). During the whole process managerial focus showed to be highly effective to stimulate exploration, exploitation or the combination of both. Management interacted directly or just followed up interactively progress in the TAR tool to switch subordinates their attention towards exploitation, exploration or ambidexterity. Overall we can conclude that there is some truth about “What gets measured, gets done”.

V. Case study learnings

Figure 5 : Project timeline



There were **structural antecedents** at the **organizational level**: a structural separation of daily operations between the production installations and different specialized departments such as the TAR department, engineering, rotating equipment, scaffolding...

Daily installation activities focused on exploitation are two-yearly interrupted by a TAR-project (**sequential antecedents** at the **organizational/project level**). The specialized TAR-department at the ChemBE-organizational level takes on TAR management instead of the installation managers which implies **structural antecedents** at the **organizational level**. The preparation of the HI and DCS investments were initiated respectively in 2012 and 2010 and the preparation was already busy before the TAR2015 started. When the upcoming TAR projects were scheduled, it was decided that both needed to be combined with the IM&R work of the TAR2015. So initially two decentralized teams preparing HI and DCS (**structural antecedents** at **project level**) had started some years in advance. After the TAR2013, a TAR manager was appointed for the TAR2015 who initiated a third decentralized team to prepare IM&R2015 work and who composed an initial small integrated TAR management team with TAR people as well as representatives of all three teams. So during the planning three structurally separated teams (**IM&R, HI and DCS**) prepared part of the turnaround work and each team had some representatives in the integrated TAR management.

The observed **structural antecedents** at the **organizational and project levels** were not used to get a strict focus on either exploration or exploitation in line with theoretical definitions, but different structurally separated units had a different balance between exploration and exploitation. For instance, the daily operations of the production installations were mainly focused on exploitation. Nevertheless, installation operating personnel was culturally and financially triggered to explore by means of an "Innovation bonus program". Each worker focused on exploitation and could individually decide to share his/her idea. These were **contextual antecedents** at the **individual level**, but with a major focus on exploitation. The daily operations of the engineering department required a high level of both exploration and exploitation, which was another example of **contextual antecedents** at the **individual level**, but this time exploration and exploitation got both quite some attention. Within the teams preparing the HI and DCS investments or the IM&R2015 work, again such an individual focus on both exploration and exploitation existed and differed. During the TAR2015 project different people from specialized departments, the production installation, and subcontractors were allocated to separate teams that needed to prepare and/or execute TAR2015 work. This implies **structural antecedents** at the **project level**. These structural antecedents were again no strict focus on either

exploration or exploitation, but between different teams that each combined exploration and exploitation as appropriate. Within each team, specialized team members got the autonomy to combine exploration and exploitation as necessary (**contextual antecedents at individual level**).

The different team efforts were also integrated during TAR planning meetings. The TAR2015 management triggered this integration of the HI, DCS and IM&R work. This concerns **leadership-based antecedents** considering TAR management stimulated itself the integration of all exploration and exploitation done by the separate work teams, to eventually become one integrated TAR planning in the TAR tool. The integration process was demanding and required additional exploitation and exploration to get it into the tight shutdown window. Serial work paths needed to be reinvented to allow parallel work and likewise time reductions. Processes for all bottle neck work on the critical path were rethought and totally new methods were applied that required demanding additional planning efforts to meet safety, quality, time and cost limits. Integration required thus both optimization of current knowledge and capabilities within current project processes (single-loop learning) as well as drastically rethinking the overall processes (double-loop learning). Successful ambidexterity during the integration was attributed to leaders who contributed themselves to exploration and exploitation as well as triggered other people involved to do both (**leadership-based antecedents at project level**). All project coworkers involved in the planning mentioned they were convinced about the need to combine exploration and exploitation during the planning (**contextual antecedents at individual level**). Eventually the integrated planning was ready and fit within tight safety, quality, time and cost limits. These structural antecedents within project phases were combined with **sequential antecedents** at the **project level** across project phases. Again all project coworkers involved in the planning mentioned that project managers convinced them about the need to switch between a focus on ambidexterity during the planning towards a focus on exploitation during the execution (**leadership-based antecedents at project level** facilitates **sequential antecedents at project level**).

During the execution there were again **structural antecedents** at the **project level**. Only a minor part of the involved staff, the TAR management team and the crash team, were required to be ambidextrous (**contextual antecedents at individual level**). A large mechanical workforce existing of ChemBE personnel as well as many subcontractors focused exclusively on exploitation : they needed to efficiently execute the prepared planning. Before the actual work started, whereby many contractors were involved, these mechanical staff was trained to focus on safety, quality, time and cost during the execution. This was first done by a “safety café” where headmen of different subcontractors were assembled and needed to present the work they would execute during the shutdown and the necessary safety measures they would take to execute everything as planned within the obliged safety, quality, time and cost limits. They also discussed the impact of their own work on other work to ensure everyone was aware of the whole picture. Some days before the actual shutdown started, all mechanical staff arrived at the plant and also they got some formal training about safety, quality, time and cost limits. Furthermore they were also explained their tasks during the shutdown. A very strict hierarchy was built to control the safe, qualitative and time/cost efficient execution of the planned work. At daily TAR meetings senior supervisory personnel and the TAR management team interacted about work progress, planning deviations and other issues. Minor problems were solved by a “crash team” of experienced personnel that relied on exploration and exploitation by individual team members to come up with appropriate solutions (**contextual antecedents at individual level**). Furthermore they were structurally separated from normal TAR execution work which illustrated a successful form of **structural antecedents** at the **project level**. In case of major planning deviations or other issues requiring additional exploration and exploitation, the TAR management team itself again contributed to exploration and exploitation and triggered other people involved to do both (**leadership-based antecedents at project level**). It allowed to explore new knowledge and capabilities

from a ChemBE perspective by acquiring it externally. TAR management involved specialized staff from the foreign ChemCO headquarters (**leadership-based antecedents at organizational level**). TAR management even involved more senior ChemBE managers (**leadership-based antecedents at organizational level**). Subsequently, TAR management and ChemBE managers involved specialized staff from other external companies (**leadership-based antecedents at inter-organizational level**). Overall we can conclude that there was a successful reliance on structural antecedents at the TAR project level : mechanical staff were strictly focused on exploitation and crash team or TAR management by means of contextual and leadership-based antecedents focused on both exploration and exploitation. This separation between exploitation and ambidexterity, however, is again different from the traditional view that exploration and exploitation are strictly separated in case of structural antecedents. The major advantage was that most could focus on exploitation while only a minor part of all project coworkers involved during the execution needed to be ambidextrous. In addition, exploration was always combined with exploitation. This way innovation was also efficient and effective.

Post-shutdown we noticed how management triggered all staff to share their lessons learned (**leadership-based antecedents at project level**). Not only acquired knowledge and capabilities were gathered, but also insights with respect to potential improvements. Furthermore management assembled a selection of core staff in a separate meeting to discuss the lessons learned in depth (**structural antecedents at project level**). During special meetings principal TAR project members were stimulated to save all acquired knowledge and capabilities for future exploitation while also striving for exploration. Here again the managers triggered exploitation as well as exploration (**leadership-based antecedents at project level**). Besides was observed that project members individually came up with their contributions for future exploitation or exploration (**contextual antecedents at the individual level**).

We further determined the importance of **leadership-based antecedents** and **contextual antecedents** to **facilitate structural** and **sequential antecedents**.

ChemBE's topmanagement successfully fostered a solution (combination of exploration and exploitation) when an important issue required organizational as well as inter-organizational action. This already illustrates the importance of **leadership-based antecedents** at the **(inter-)organizational level** when stimulating structural antecedents at the **(inter-)organizational levels**.

Many other examples illustrated that **contextual antecedents** at the **individual level** and **leadership-based antecedents** at the **project-level** fostered the successful implementation of **sequential and structural antecedents** at the **project level**.

Attention for exploration and exploitation was part of the corporate culture. Different examples illustrate how contextual antecedents at the individual level within the project were stimulated by reinforcement of certain values, norms and other cultural aspects at the organizational or project level. An example of contextual antecedents is the strong willingness of core employees to combine exploration and exploitation ; during the planning of the different IM&R, HI and DCS work and the integration into one turnaround planning, to solve any planning deviations and issues during the execution and to contribute to the lessons learned process post-shutdown. Involvement in the planning processes even increased the understanding and commitment of all core members involved. These ones later controlled the accurate execution of the planning by the mechanical workforce and stimulated the focus on optimal exploitation of earlier planning efforts. Furthermore the crash team and TAR management team their involvement in the planning enabled them to react ad hoc when issues during the execution required a combination of exploration and exploitation. These examples

illustrate that **contextual antecedents** at the **individual level** and **structural** and **sequential antecedents** at the **project level** can be mutually reinforcing.

TAR management successfully triggered all project members to combine exploration and exploitation during the preparation and integration of the planning as well as to contribute in the lessons learned process post-shutdown. During the turnaround execution TAR management let all mechanical staff focus on exploitation while they triggered themselves directly and indirectly ambidexterity within the TAR management team and crash team to solve planning deviations and other issues. But management also forced the switch in focus between the phases. **Leadership-based antecedents** at **project level** were thus helpful to implement **structural antecedents** at the **project level** within planning and execution phases as well as **sequential antecedents** at the **project level** across the phases.

In sum, case study research in one turnaround project learned that (1) project ambidexterity co-occurred with of a combination of structural, sequential, contextual and leader-ship based antecedents. It is important to consider the four antecedents of ambidexterity across time and multiple levels of analysis to be able to notice all different types. (2) The four antecedents of ambidexterity are not just stand-alone phenomena but interrelated practices that together create the ambidexterity capability. While structural, sequential, contextual or leader-ship based antecedents can foster ambidexterity on their own, (3) contextual antecedents (at the individual level) and leadership-based antecedents (at the project level) are helpful to overcome the typical inertia that impede the combination of exploration and exploitation (**structural antecedents**) or switching between them (**sequential antecedents**).

We conclude that turnaround projects displayed successful achievement of ambidexterity. Nevertheless, the overall “project ambidexterity”-term does not encompass the whole story. All four antecedents of ambidexterity were combined among inter-organizational, organizational, project and individual levels. In table 4 we summarize the findings.

Table 5: Summary antecedents of ambidexterity across levels of analysis

Level	Inter-org.	Org.	TAR project	Individual
				IMR2015
Type				
Structural		x	x	
Sequential		x	x	
Contextual				x
Leadership-based	x	x	x	

Furthermore we noticed two special combinations of antecedents that were in fact a combination of different antecedents of ambidexterity. During the planning the HI and DCS investment teams had a considerable higher need for exploration than the IM&R team considering the uniqueness of their work. Nevertheless, all three work teams also needed to exploit optimally. The eventual decomposition demonstrated a structural separation between work teams with a different focus and need for exploration (see Figure 6).

During the execution there was a structural separation between the mechanical work force that focused on exploitation and the crash team that needed to combine exploration and exploitation. In addition, TAR management needed sometimes to combine exploration and exploitation itself,

stimulate the crash team to do this while keeping the mechanical work force focused on exploitation. This was again a combination of multiple antecedents of ambidexterity (see Figure 7).

Figure 6 : Structural & contextual antecedents

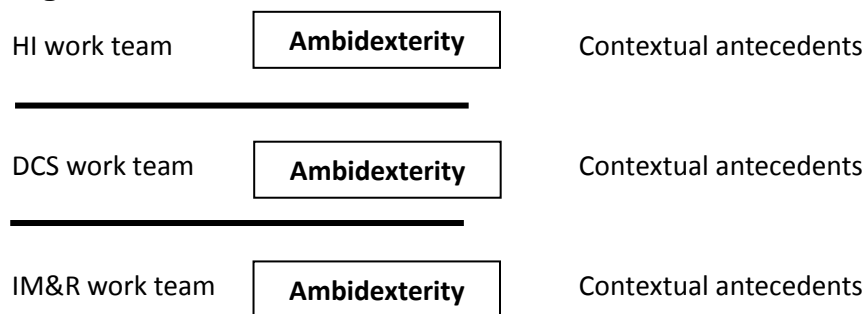
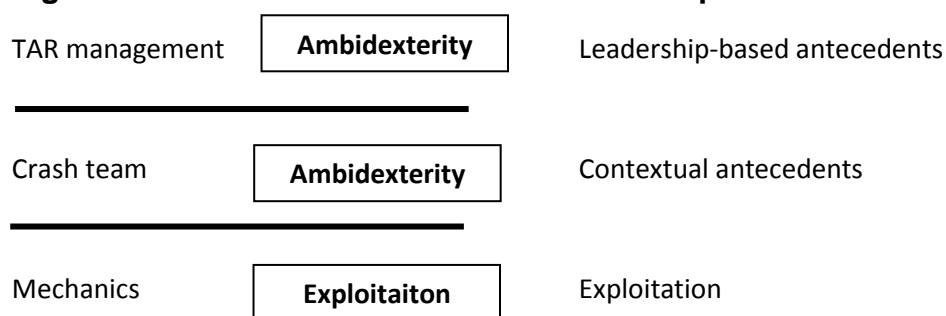


Figure 7 : Structural & contextual & leadership-based antecedents



VI. Discussion :

Consideration of all four antecedents of ambidexterity at different levels of analysis and across course of time illustrates that project ambidexterity can occur in a context that contains multiple antecedents. We discuss the contributions to the literature. We start with describing how the observed case study learnings contribute to ambidexterity literature.

Raisch, and Birkinshaw (2008) referred to the use of primary structures to do routine tasks efficiently and the use of supplementary structures to realize non-routine tasks and innovation. Such **sequential antecedents** were found in our case at **organizational level**. The primary structures at the installation focused on efficient daily operations. The TAR organization occurred largely by supplementary structures and focused on both exploration and exploitation. In traditional businesses, long periods of exploitation are alternated by short periods of exploration (Brown & Eisenhardt, 1997), which makes that employees are more familiar with and more focused on exploitation (Gupta et al., 2006). **Structural antecedents** at the **organizational level**, whereby a specialized TAR department existed at ChemBE, demonstrated its effectiveness by involvement of TAR specialists who were used to turnaround requirements. The existence of a specialized TAR department with own structures and a formalized TAR process instead of leaving TAR management to the discretion of operating staff of the installation supports earlier research findings that suggest switching from time to time between formal structures is far more easy than changing the culture and informal organization (Nickerson & Zenger, 2002; Boumgarden et al., 2012). There were thus **structural antecedents** at the **organizational level** (between installations and specialized departments) and **sequential antecedents** at the **organizational level** (daily operations were interrupted by the TAR2015).

Within the TAR2015 we observed **sequential antecedents** at the **TAR-project level**. The project's complexity normally declines when the project progresses considering unknowns become knowns as the period towards uncertainties shrinks (Maylor, Turner, & Murray-Webster, 2013). Therefore sequential antecedents are often expected in projects. Liu and Leitner (2012) concluded that a temporal separation is even most appropriate for a project context because a structural separation of teams is ineffective to cycle between exploration and exploitation and to implement both under time pressure and resource constraints. O'Reilly and Tushman (2013, p. 327) referred to a simulation study by Siggelkow, and Levinthal (2003) who suggested that *"sequencing changes in organizational structure to promote temporary decentralization can be an effective way of exploring and exploiting"*. This temporary decentralization was noted during the planning phase of the TAR2015 as an effective way to leave smaller teams the necessary space to optimally combine exploration and exploitation. The temporary decentralization during the **planning** was thus a combination of **sequential antecedents** at the TAR2015 **project level** with a high level of ambidexterity during the planning phase, as well as successful **structural antecedents** at the TAR2015 **project level** whereby the planning preparation was decentralized into smaller specialized teams. During the **execution** the focus switched to exploitation for the numerous mechanical staff (**sequential antecedents** at the TAR2015 **project level**) but again a structural separation was noticed with regard to planning deviations and issues (**structural antecedents** at the TAR2015 **project level**). These were the responsibility of the TAR management team and crash team.

O'Reilly and Tushman (2013) noticed a high level of abstraction in current literature and a lack of research clarifying how sequential antecedents, and more especially the transition between exploration and exploitation, are implemented at the operational level. We noticed how **leadership-based antecedents** at TAR **project level** and **contextual antecedents** at **individual level** showed valuable complements with sequential antecedents and created top-down managerial as well as

widely shared cultural stimuli that were incorporated by coworkers and enabled sequential antecedents. Gupta et al. (2006) indicated exploration and exploitation require different organizational routines and mindsets which make it harder to combine them. Substantial differences in routines and focus on learning, may hinder an individual or even subsystem to combine or even switch between routines of exploration and exploitation. Combining both simultaneously is more easy for a group, organization or another larger system than for individuals (Gupta et al., 2006). Project planning teams, TAR management, the crash team and the lessons learned processes, however, indicated that within small teams individuals combined exploration and exploitation when subject to contextual antecedents. Gupta et al. (2006) conclude in their review article on ambidexterity that exploration and exploitation are either considered as two ends of a continuum or as two orthogonal concepts. Like this they are respectively competing or complementary aspects of organizational decisions and actions (Simsek et al., 2009). In line with the orthogonal approach of Gupta et al. (2006), contextual antecedents imply that the same people combine exploration and exploitation so these are coexisting instead of mutual exclusive (Turner et al. 2013). Like this there is no competition for scarce resources since both are strived for simultaneously (Gupta et al., 2006; Raisch et al. 2009). We observed how contextual antecedents created a supportive business-unit context that allowed individuals to simultaneously handle ambidextrous requirements within the same unit and even to switch with the unit between phases of sequential ambidexterity. This was in line with earlier research of Liu and Leitner (2012) that found that temporal cycling can be facilitated by a project context that overcomes inertia and directs people's attention to achieving the best outcome for the project.

O'Reilly and Tushman (2013) question the appropriateness of contextual ambidexterity in case of disruptive or discontinuous change where significant restructuring and resource reallocation are necessary because such decisions require top management involvement rather than to be left to the discretion of employees. We noticed contextual antecedents were effective in combination with leadership-based antecedents (at TAR level) during planning, execution and post-shutdown. Both antecedents were no substitutes but complements which substantiates the **need for further holistic ambidexterity research**. In addition the solution process of the disapproved axle during the project execution illustrated how leadership-based antecedents contributed to successful combination of organizational and inter-organizational structural antecedents. There the case study illustrates the complementarity of **leadership-based antecedents** at the **inter-organizational, organizational and project level**. This is a contribution to for instance O'Reilly, and Tushman (2013) who referred to various studies how inter-organizational or community setting and intra-organizational structural ambidexterity are complements and the combination of internal ambidexterity and external partnerships has a positive relationship on firm performance.

A TAR manager from the TAR department was in the lead for the turnaround project (**leadership-based antecedents** at the turnaround **project level**) and successfully managed the whole turnaround. This manager was able to cope with the varied organizational architectures and the multiple cultures, partly because their relatively long tenure in the organization whereby they have become familiar with the organizational architectures and have become the embodiment of the corporate culture, and were still willing to change continuously to meet the future. This is completely in line with the findings of Tushman, and O'Reilly (1996). O'Reilly and Tushman (2013) mention the successful achievement of ambidexterity requires leaders who allocate resources between exploration and exploitation. They noticed that the core of the leadership challenge is to unravel how managers can do this despite the inevitable conflicts. Nevertheless, they indicated this aspect of leadership-based antecedents has remained understudied and asked for more qualitative and in-depth studies. O'Reilly and Tushman (2013, p. 333) also indicated two understudied topics with regard to leadership-based antecedents: (1) *“how firms and their leaders can promote new cultures and identities that accommodate exploration*

and exploitation” and (2) “the need for research on leadership capabilities in leading across boundaries as well as identity issues that span the firm/community boundaries.” The research gap about this managerial capability was also mentioned by Birkinshaw and Gupta (2013, p. 293) “To really make progress on how ambidexterity is achieved, we need much more insight into the nature of managerial capability. We know some organizations are more ambidextrous than others, but for this insight to be valuable we have to take a more detailed look at the way they make their decisions, who gets involved in those decisions, and how those decisions are implemented.”

An important contribution of this case study is that leadership-based antecedents were effective in combination with contextual antecedents to implement structural and sequential antecedents, whereas Liu, and Leitner (2012) found no structural antecedents in another project case. Despite different interviewees recognized the need for a strong leader who dares to take decisions if the team gets stuck, they also told that this was not often the case during this project. The participation of subordinates in the decision process was even essential for project ambidexterity. Top-down **leadership-based antecedents** at TAR-project level and bottom-up **contextual antecedents** at the **individual level** were complementary with **structural** and **sequential antecedents** at TAR-project level. All personnel involved in the turnaround project got their tasks that could differ depending on the time (sequential antecedents) and team (structural antecedents). Leadership-based and contextual antecedents were effective to let them focus on exploitation, exploration or a combination of both. We thus contribute to literature by demonstrating how the effectiveness of leadership-based antecedents is not just dependent on managerial capabilities but needs to be considered together with other antecedents of ambidexterity. We focused on the observed project ambidexterity within the TAR2015. We could not notice any inconsistencies in how the antecedents were combined in this case, but we did notice complementarities between the antecedents of ambidexterity. Furthermore, the observed existence of ambidexterity favors the orthogonal view that assumes coexistence or even complementarity of exploration and exploitation (Gupta et al., 2006). Despite individuals were able to achieve high levels of both, proving the existence of contextual antecedents, it only gives limited insights for the orthogonal view. We do not proof that individuals could not achieve higher levels of either exploration or exploitation by focusing on only one. Experimental research could try to disentangle these effects.

Previous literature had emphasized that efforts need to be integrated. Targeted integration can merge people, structures, processes and cultures in different units to make sure that resources and capabilities are effectively used (Tushman and O'Reilly III, 1996). Possible integration mechanisms mentioned in literature are a common strategic intent, an overarching set of values and targeted linking mechanisms (O'Reilly and Tushman, 2004). But also organizational culture (Lin and McDonough III, 2011) and leadership based antecedents (O'Reilly and Tushman, 2013) were mentioned as potential integrator mechanisms for structurally or sequentially separated exploration and exploitation. And this is now also illustrated in practice by our case study : leadership-based and contextual antecedents contributed to the integration in case of structural and sequential antecedents. Hereby **contextual antecedents** at the **individual level** and **leadership-based antecedents** at the **organizational** and **project level** facilitated **sequential** and **structural antecedents** at the **project level** as well as the **organizational level**. **Leadership-based antecedents** were even observed at the **inter-organizational level, organizational** and **project level**. The case study highlights the value to consider multiple levels of analysis in future research as well which substantiates Birkinshaw and Gupta (2013, p. 294) their conclusion that ambidexterity is a multilevel construct. They considered ambidexterity as a "nested" concept with some blend of exploration and exploitation at multiple levels in the organization simultaneously. Nevertheless, they noticed a lack of studies that explicitly considered two or more levels of analysis simultaneously. Birkinshaw and Gupta (2013, p. 294) further mentioned that

ambidexterity research should clarify who eventually ends up taking responsibility for managing the tension between exploration and exploitation. This case study clarifies how sequential and structural antecedents are complemented with contextual and leadership-based antecedents whereby both the individual and the leader take up responsibility.

VII. Conclusions

By means of an extent case study that considered multiple levels of analysis and the course of time in one TAR project, we delivered a clear overview of the ***antecedents of ambidexterity***. The case demonstrated the successful achievement of project ambidexterity. The project context was characterized by *all four antecedents* of ambidexterity: sequential, structural, contextual and leadership-based antecedents. *Antecedents of ambidexterity* occurred at *individual, project, organizational as well as inter-organizational level*. We found structural antecedents at the organizational level (e.g., installation, TAR department, engineering department...) and project level (e.g., HI, DCS and IMR planning teams). We found sequential antecedents at the organizational level (e.g., installation's daily operations are interrupted by a TAR project during a shutdown) and on a project level (e.g., changed focus on exploration and exploitation between planning, execution and post-shutdown phases in one TAR project). There were contextual antecedents at the individual level within different work teams (e.g., people preparing the HI, DCS or IMR work, the TAR integration or solving problems during the execution as part of the crash team). Contextual antecedents at the individual level also enabled sequential and structural antecedents at the project and organizational level. Leadership-based antecedents occurred at the inter-organizational, organizational and project level. Leaders strived themselves for exploration and exploitation when needed but also fostered the successful implementation of structural and sequential antecedents at inter-organizational, organizational or project level.

The empirical findings contribute to different literature streams. Ambidexterity and project literature benefit from (1) the *empirical decomposition into different antecedents of ambidexterity* - we noticed combination of *structural, sequential, contextual or leader-ship based antecedents* - and (2) description of the *interdependency* between antecedents of ambidexterity. (3) It illustrates *how* combinations of antecedents proved important, e.g. contextual and leadership-based antecedents can facilitate structural and sequential antecedents. Furthermore, it demonstrates that (4) leadership-based antecedents should be definitely included as category of antecedents in future research.

The case study occurred in the setting of a specific turnaround project. (1) The single case study limits the generalizability of the findings. It is possible that other projects (different size, organization, etc.) in other contexts (different uncertainty, complexity etc.) and with other objectives, deliver varying findings. It is possible that other studies in other settings would illustrate potential inconsistencies that did not occur or remained unnoticed in this case study. Replication research needs to be done for other projects and other contexts. (2) Furthermore, despite the holistic approach, not all factors could be considered in one case study. Omission of certain factors may have impacted the findings. Future cross-sectional studies should control for additional variables. (3) It was often difficult to delineate a complex reality with different antecedents of ambidexterity across levels of analysis. In addition, a better understanding of interdependencies still needs to be developed. Large-scale survey studies will allow possibly to find correlation and deliver additional understanding on the antecedents of ambidexterity, appropriate levels of analysis and interdependencies. (4) Concepts as antecedents of ambidexterity are now measured through observation and interviews. Despite the high consistency in findings during this case study, the concepts used in the case study need further specification to eventually lead to

concrete constructs that facilitate quantitative research. Additional research should also try to disentangle effectiveness of the different specific antecedents of ambidexterity per level, and their interrelatedness. (5) Furthermore we found that leadership-based antecedents are a full type of ambidexterity. Considering the limited research about leadership-based antecedents and its combinations with other antecedents of ambidexterity, future research should clarify these.

VIII. Literature

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Paper 2: Management controls fostering ambidexterity in projects: making the case for hybrid control packages

Management controls fostering ambidexterity in projects: making the case for hybrid control packages

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Paper category: case study

Abstract : This paper describes a case study in which we investigated how a management control package could foster exploration and exploitation during one complex integrated project that combined inspection, maintenance and repair work with innovative capital investments. The objective is to perform a holistic and in-depth investigation of the management control package in one particular situation, which was described in literature to be under-researched in previous studies. A case study in one of the leading multinational chemical companies was performed, in which data was collected through observation, interviews, meetings and analysis of procedure manuals. The results demonstrate that a hybrid control package, combining diverse control practices, facilitated to foster both exploration and exploitation simultaneously without tensions were experienced. Additionally, we describe how combinations of controls were used to foster exploration and/or exploitation, whereby the emphasis on specific controls as well as on their influence on exploration and/or exploitation varied during the different project phases. No incompatible needs for exploration and exploitation were noticed when they were combined which substantiated the orthogonal ambidexterity view. Furthermore, we found that the hybrid control package stimulated single as well as double learning. This learning in turn stimulated timely adaptation of the control package to changes in the complex dynamic environment. Future research should focus on external validity to verify if a hybridization of management controls can foster similar positive results in other contexts or if other packages than the one used in this case study can be as effective when striving for ambidexterity. This article describes indispensable insights for organizations that need to manage exploration and exploitation simultaneously. The paper provides some lacking insights in how hybrid control packages lever the different controls separately and jointly in order to successfully achieve ambidexterity in reality. In addition, it provides insights in how single- and double-loop learning processes are stimulated in real-life.

Keywords : project, ambidexterity, management control, hybrid control package, exploitation, exploration, efficiency, innovation

Paper category : case study

I. Introduction

Organizations benefit from an *ambidextrous* business strategy (Raisch, and Birkinshaw 2008, O'Reilly, and Tushman 2013). Ambidextrous firms combine a long-term focus on innovation (*exploration*), with a short-term focus on efficiency (*exploitation*) (Benner and Tushman 2003, Tushman and O'Reilly III 2006, Raisch, Birkinshaw et al. 2009). Nevertheless, ambidexterity research indicates a lack of research clarifying how ambidexterity can be managed at the operational level (Birkinshaw, and Gupta 2013). The purpose of this paper is threefold : (1) discovery of a package of management controls used to foster ambidexterity, (2) clarification how controls within the package individually and/or jointly foster ambidexterity, and (3) investigation of the relation between exploration and exploitation: should they be considered as two opposing ends of one continuum (more of one means less of the other) or as orthogonal concepts (more of one is independent of more or less of the other).

According to O'Reilly and Tushman, what is missing is “*a clear articulation of those specific management actions that facilitate the simultaneous pursuit of exploitation and exploration*” and “*a greater insight into the specific micro mechanisms required for a manager to implement and operate an ambidextrous strategy.*” (2011, p. 8) Furthermore, earlier management control studies mostly investigated the impact of isolated specific control mechanisms, but there is a need for research that investigates management controls as a holistic package (Drazin and Van de Ven 1985, Malmi and Brown 2008, Bedford and Malmi 2015). Our study relies on the management control typology used by Bedford and Malmi (2015) to define, by means of survey research among top managers, a taxonomy of five management control packages: simple, results, action, devolved and hybrid packages. Despite earlier research indicated the incompatibility of different control modes (e.g. Burns, and Stalker, 1961, Ouchi 1977, Mintzberg 1979, Ouchi 1979, Mintzberg 1989), a hybridization of multiple control modes was detected in 30,25% of the sample of Bedford and Malmi (2015) and it was also observed in this case study.

The *hybrid package* comprises an extensive use of three control types. In particular, *policies and procedures*, normally associated with bureaucratic structures, are used to imply compliant behavior. *Measurement* aims for results control (e.g. performance measurement systems). *Socio-ideological controls* stimulate individual behavior by the creation of shared values, norms and beliefs. The use of this hybrid package of controls does not adhere to previous theories in management control. These theories assume that one control type must be dominant to effectively control the behavior of individuals and groups (e.g. Burns and Stalker 1961, Ouchi 1977, Mintzberg 1979, Ouchi 1979, Mintzberg 1989), because structural tensions are expected when different control types are applied simultaneously. However, Bedford and Malmi (2015) already suggested that the *hybrid package* may foster ambidexterity in organizations, based on previous ambidexterity research that claimed a combination of diverse control modes is necessary to pursue exploration and exploitation simultaneously (Tushman and O'Reilly III, 1996, Raisch and Birkinshaw, 2008, O'Reilly and Tushman, 2013).

To address the research questions, we performed an in-depth single case study to investigate the control systems used by a chemical firm (nickname ChemCO) to achieve ambidexterity in a turnaround project. A turnaround (or TAR) project aims to successfully plan and perform all required operations, maintenance and capital project work during a planned shutdown of an installation. It concerns the entire set of activities, tools, equipment, materials, and personnel that is necessary to achieve this goal. During the investigated TAR2015 project, two innovative and complex capital investments needed to be combined with shutdown work for regular inspection, maintenance and repair work (IMR). Not only the investments and regular IMR as such required both exploration and exploitation,

also the integration with related items required significant exploration and exploitation (of the standardized turnaround processes that were used for earlier turnaround projects). Current standardized best practices were not sufficient and breakthrough planning efforts were required to get the planning within safety, quality, time and cost requirements.

Different interesting observations were made in the case study. We learned from the case that (1) a hybrid package of controls fostered ambidexterity. It also clarified that (2) both individual controls and the joint package of controls supported successful exploration and exploitation and that (3) the case study clarifies that the emphasis in the use of controls in the project context was not static but changed dynamically during the process cycle of the project. (4) No opposing needs or other tensions were noticed within the control package and between the different control modes, indicating that exploration and exploitation can be orthogonal concepts. Furthermore, the case demonstrated that (5) the hybrid package stimulated both single and double loop learning and that (6) these learning processes counteracted inertia and facilitated timely adaptation of the control package to changes in the ambidexterity requirements in the complex dynamic environment.

Our results contribute to the literature (1) by finding concrete evidence *that* a hybrid package of management controls indeed can support ambidexterity, (2) by explaining *how* a hybrid control package has an impact in achieving ambidexterity, (3) by expanding the body of knowledge about the *dynamics* of the use of a hybrid control package, (4) by demonstrating that different control modes can be successfully applied in a *joint* synergetic setting without conflicts (which is a contribution to management control research), (5) by demonstrating that exploration and exploitation can exist as *orthogonal* concepts (contribution to ambidexterity research), and (6) by expanding our knowledge of single and double loop *learning* in a project context.

The paper structure contains (I) introduction, (II) literature review and formulation of the research questions, (III) methodology, (IV) case background, (V) results, (VI) case study learnings, (VII) discussion and (VIII) conclusions, limitations and directions for future research.

II. Literature review and research questions

II.1. Ambidexterity

II.1.1. Ambidexterity research : What is an ambidextrous organization

Organizational ambidexterity is the ability of firms to excel at both exploration and exploitation (Tushman and O'Reilly III, 1996, Raisch and Birkinshaw, 2008, Andriopoulos and Lewis, 2010). *Exploitation* is linked with efficiency, control, certainty, refinement, variance reduction, implementation, execution and often has a short-term orientation. We consider all reuse and refinement of existing knowledge, competencies and capabilities as exploitation. *Exploration* is about innovation, autonomy, search, experimentation, risk-taking, discovery, flexibility, and takes a long-term orientation. We consider the development or search for new knowledge, competences and capabilities as exploration, regardless if it is single or double loop learning. Ambidextrous firms are capable to combine a short-term focus on efficiency by exploiting existing knowledge, competences and capabilities, with a long-term focus on innovation and strategic development that requires exploration of new knowledge, competences and capabilities (Benner and Tushman 2003, Tushman and O'Reilly III 2006, Raisch, Birkinshaw et al. 2009). Ambidextrous firms are "aligned and efficient in their management of today's business demands while simultaneously adaptive to changes in the environment" (Raisch and Birkinshaw 2008). These definitions are similar to the ones Turner, Swart and Maylor (2013, P320) deduced from their literature review "*Ambidexterity is the ability to both use and refine existing knowledge (exploitation) while also creating new knowledge to overcome knowledge deficiencies or absences identified within the execution of the work (exploration).*"

Raisch and Birkinshaw (2008) conclude based on extensive previous research that ambidexterity is positively associated with firm performance and that environmental variables such as uncertainty and the availability of sufficient resources reinforce the association between ambidexterity and performance. O'Reilly and Tushman (2013, P325) their literature review summarizes theoretical papers, case studies, anecdotal evidence as well as more recent studies using large samples with longitudinal data. They again observe a dominant positive association of ambidexterity with sales growth, subjective ratings of performance, market valuation as measured by Tobin's Q and firm survival. They also find that these positive performance effects of ambidexterity are stronger in case of environmental uncertainty, increased competitiveness and sufficient organizational resources which often occurs in larger firms. O'Reilly and Tushman (2013, P326) conclude that "*the results linking ambidexterity to performance are robust, (...) despite using different measures of ambidexterity, a range of outcome variables, different levels of analysis, and samples from differing industries.*"

Nevertheless, relatively few firms are able to combine exploration and exploitation (e.g. Sarkees and Hulland, 2009). The proposed reasons depend on the ambidexterity view. Birkinshaw and Gupta (2013, P294) noticed "*The ambidexterity literature is extremely vague on whether two different objectives should be balanced, traded off against one another, reconciled, or simply managed.*" Ambidexterity research either considers exploration and exploitation as two opposing ends of a continuum or as two orthogonal concepts (Gupta, Smith et al. 2006).

The opposing ends of a continuum implies that decisions and actions imply some competition (Simsek, Heavey et al., 2009) whereby either exploration or exploitation or some balance in between is achieved. It implies tensions between management of exploration and exploitation. Gupta, Smith et al. (2006) summarize from earlier research that there are different reasons used to assume this. First, firms have limited organizational resources that need to be divided between exploration or exploitation. Secondly, exploration more likely ends up in failure and continuing with more exploration (failure trap). Exploitation leads to early (short-term) successes and also reinforces itself (success trap). Thirdly, exploration or exploitation require different organizational routines and mindsets. This routines and mindsets then again make it more likely to explore or exploit more. O'Reilly and Tushman (2013) mention different researchers that share the view that different structural alignments are needed for exploration and exploitation, for instance He and Wong (2004, P481): *"exploration and exploitation require substantially different structures, processes, strategies, capabilities, and cultures to pursue and may have different impacts on firm adaptation and performance."* Opposing needs and tensions between the structures appropriate for either exploration and exploitation then impede ambidexterity.

On the contrary Birkinshaw and Gupta (2013) conclude from a literature review of current ambidexterity research that exploration and exploitation are not opposing poles on a continuum but orthogonal concepts that need to be measured as two separate dimensions. Diverse empirical studies also illustrate the ability of some firms to successfully combine exploration and exploitation. Sarkees and Hulland (2009) even empirically demonstrate by means of survey research among publicly traded US firms that firms which combine high levels of both exploration and exploitation outperform those which overemphasize either exploration or exploitation. They did describe how managers often favor exploitation above exploration when allocating scarce internal resources because exploitation more likely leads to short term performance effects while performance effects of exploration are often lagging. Nevertheless, exploration and exploitation are now not considered as opposing concepts but as orthogonal concepts that can reinforce each other : *"it confirms that efficiency and innovation can be complementary rather than contradictory strategies, as other management researchers have suggested"* (Sarkees and Hulland, 2009, P49). Gupta, Smith et al. (2006) conclude from literature that exploration and exploitation can either coexist as two mutually exclusive ends of a continuum, but can also coexist which implies an orthogonal or dualism view. Like this there is probably no competition for scarce resources since both are strived for simultaneously which matches contextual ambidexterity. Nevertheless, simple co-existence is not enough to consider that no tensions are noticed when combining both. Birkinshaw and Gupta (2013, P293) for instance state that ambidexterity is really difficult to achieve *"March (1991) provided a theory to explain his observation that exploration and exploitation represent self-reinforcing patterns of learning. I agree with this observation. However, I don't believe he is saying that it is impossible for organizations to overcome these self-reinforcing patterns; he is just saying that it is extremely difficult."* Management control research is then essential for ambidexterity research as stated by Birkinshaw and Gupta (2013, P294) *"one of the central concerns of ambidexterity research is how two different objectives might be effectively managed"*. So not the existence of management as such is sufficient but the quality of management is key (Birkinshaw and Gupta, 2013). Birkinshaw and Gupta (2013) considered exploration and exploitation as self-reinforcing patterns which are difficult to overcome considering organization's do have a tendency to go down the path of least resistance. Nevertheless they P293 conclude *"managers are making choices and trade-offs among competing objectives, and when they do their job well they override the organization's tendency to go down the path of least resistance. (...) Or, to put it even more simply, why else do we need managers other than to help organizations do the things that don't come naturally to them? If managers allowed exploration and exploitation to self-*

reinforce, without intervention, then their organizations would quickly fail". Nevertheless Birkinshaw and Gupta also state (2013, P293) "It is important to keep in mind that ambidexterity is really hard to achieve." Management control research is therefore one of the areas where ambidexterity research has the most potential (Birkinshaw and Gupta, 2013, P293) "To really make progress on how ambidexterity is achieved, we need much more insight into the nature of managerial capability. We know some organizations are more ambidextrous than others, but for this insight to be valuable we have to take a more detailed look at the way they make their decisions, who gets involved in those decisions, and how those decisions are implemented."

II.2. Management control research : How to realize ambidexterity in projects

Ambidexterity literature has demanded research about the actual managerial practices used by firms that are able to be ambidextrous. Management control research is thus required to understand how exploration and exploitation can be combined in practice.

Management controls are all processes and mechanisms, e.g. devices, systems, rules, practices, values and other activities, used by managers to influence the behavior of individuals and groups towards more or less predetermined organizational objectives and strategies (Flamholtz, Das et al. 1985, Speklé 2001, Langfield-Smith 2006, Malmi and Brown 2008, Bedford and Malmi 2015). Nevertheless, both practitioners and academics signal a deficiency in literature that empirically or theoretically examines the interaction effects between multiple control mechanisms (Drazin and Van de Ven 1985, Malmi and Brown 2008, Bedford and Malmi 2015). Investigating which mechanisms that tend to be observed in combination would enable researchers to identify possible complementarity or substitutability between control mechanisms (Grabner and Moers 2013). Therefore research should first investigate single management controls holistically as part of the wider management control package they belong to (Flamholtz, Das et al. 1985, Dent 1990, Fisher 1995, Malmi and Brown 2008, Grabner and Moers 2013, Bedford and Malmi 2015). A package of management controls is defined by Grabner and Moers (2013) as *"the complete set of control practices in place, regardless of whether the MC practices are interdependent and/or the design choices take interdependencies into account"*.

The levers of control (Simons, 1994,1995) offer one framework for management controls that is often used in literature. It is an excellent framework to discuss, for instance, the way top management steers an organization. This study, however, focuses on the operational level. A recent, easily applicable framework for management controls, is the Malmi and Brown (2008) framework. Their typology contains more recent developments in MCS design (such as hybrids like the BSC), and includes forms of control that have received less attention in empirical research, such as cultural controls. Malmi and Brown (2008) have done *a theoretical a priori specification of control categories to provide a new typology for all kinds of control mechanisms*. It broadly maps the tools, systems and practices managers have available to formally and informally direct employee behavior towards the organization's objectives and strategy into five groups: planning, cybernetic, reward and compensation, administrative and cultural controls.

The Malmi and Brown (2008) framework as such only offers an overview of management controls classified into categories. Nevertheless, the typology of Malmi and Brown (2008) can be helpful to describe a package of controls. Bedford and Malmi (2015) slightly adapted the Malmi and Brown-framework for management control mechanisms into a typology of six categories of control: *planning, measurement, compensation, structure, policies and procedures*, and *socio-ideological* control mechanisms. Subsequently Bedford and Malmi (2015) used this typology to empirically retrieve by means of survey research a taxonomy of five control packages used by top managers in their cross-sectional sample of 400 firms: the simple, results, action, devolved and hybrid control package. In

theory, many variables can form an enormous number of combinations but they could only find five packages of management controls. Bedford and Malmi (2015) just as Sanchez (1993) concluded that exogenous and/or endogenous forces will force organizations' structural and contextual traits to converge into a finite number of empirically identifiable patterns. On the one hand exogenous forces, such as environmental selection and competition, effectively limit the number of viable combinations (Hannan and Freeman 1993, Bedford and Malmi 2015). On the other hand endogenous pressures lead to configurations with an internally consistent logic (Child 1972). Also Chenhall and Langfield-Smith (1998) earlier provided support for the idea that internally consistent arrangements enhance firm performance. So on the one hand packages should be driven by internal fit, on the other hand they should be driven by a contingency form of fit. Bedford and Malmi (2015)'s five clusters of mechanisms do coexist in practice in a particular context. However, these authors call for more research to develop parsimonious models that are at a reduced risk of producing spurious results and to understand how these control mechanisms work (Bedford and Malmi 2015).

It is known that firms can achieve ambidexterity if they combine multiple control modes (Raisch and Birkinshaw 2008, Tushman and O'Reilly III 1996). O'Reilly and Tushman, (2013, P333) concluded "*Pressures may require firms to adopt more hybrid organizational structures*". When using *different* control types simultaneously, structural *tensions* are expected. Previous theories in management control mostly assumed that *one* control type should be dominant to effectively control the behavior of individuals and groups (e.g. Burns and Stalker 1961, Ouchi 1977, Mintzberg 1979, Ouchi 1979, Mintzberg 1989). Managers mainly rely on three ways to influence subordinates: they control their behavior, they measure their results or they motivate the subordinates to do the right things. *Policies and procedures*, normally associated with bureaucratic structures, are used to imply compliant behavior. *Measurement* (e.g. performance measurement systems) aims for results control. *Socio-ideological controls* stimulate individual behavior by the creation of shared values, norms and beliefs. The same three control types could be retrieved in the packages found by Bedford and Malmi (2015). One control package, the simple control package, ranked low on all control modes. Three other control packages indeed relied mainly on one control mode. Measurement was essential for the results control package, policies and procedures for the action control package and socio-ideological controls for the devolved control package. A results control package strongly relies on measurement systems integrated in a hierarchical structure. Nevertheless, both the action control package and devolved control package relied on measurement to some extent as well. An action control package mainly relies on flexible-bureaucratic configurations existing of policies and procedures integrated into an organic structure, but it comprises to a lower level measurement systems whereby measurement is again activated in an interactive fashion. A devolved control package has a main focus on socio-ideological controls instead of policies and procedures but again relies as well to a lower level on measurement systems activated in an interactive fashion in an organic structure. The hybrid control cluster encloses all these different control types too a very high extent into one package. Measurement is combined with a complex hybridization of policies and procedures as well as socio-ideological controls within mechanistic as well as organic structures. Despite structural tensions were expected when using different control types simultaneously, Bedford and Malmi (2015) found in practice that this hybrid type was frequently present in the sample of the companies investigated (30,25 %). The hybrid control package was not entirely novel as case-based research described organizations with similar structures, e.g. Alvesson and Karreman (2004) where tensions were noticed. But the findings of Bedford and Malmi (2015) indicate that these distinctly contemporary organizational forms are more common in practice than the literature suggested at that time. Still the frequent coexistence of different control modes does not confirm or disprove the presence of tensions between these control modes. Further

research could contribute to the orthogonal view if no tensions are found. If control modes occur together but tensions are noticed, this would substantiate the two ends of a continuum approach.

Bedford and Malmi (2015) suggested that the *hybrid type* may foster ambidexterity in organizations based on previous ambidexterity research that suggests a combination of diverse control modes is necessary to pursue exploration and exploitation simultaneously (Raisch and Birkinshaw 2008, O'Reilly and Tushman 2013). However, as far as we know, no studies have empirically investigated which management control package can effectively facilitate ambidexterity. So the following research question has been unanswered so far in literature.

RQ 1 : Which management control package fosters ambidexterity in projects?

Furthermore Bedford and Malmi (2015) asked for more research to unravel *how* the diverse packages function in an organization. How are ambidextrous strategies implemented from the management control perspective? In sum, the following research question has been unanswered in previous studies, as far as we know.

RQ 2 : How does the management control package enable ambidexterity in projects?

We will investigate which elements of the package stimulated an effective and efficient implementation of exploration and/or exploitation. In addition, we will investigate how this happened. We will also investigate which elements of the package obstructed an effective and efficient implementation of exploration and/or exploitation. And again, we will investigate how this happened.

We will thus also indirectly investigate if there are tensions between management controls within the package. Tensions would substantiate the two ends of a continuum-view whereas the combination of exploration and exploitation without any tensions in the management control package would leave the possibility of an orthogonal view.

III. Methodology

3.1 Packages of controls

The package of management controls appropriate to implement an ambidexterity strategy and how this actually occurs has *not been earlier investigated in management control*. The typology of management controls used by Bedford and Malmi (2015) seems a well-defined and well-structured framework of management controls to do this. We will use the typology as used by Bedford and Malmi (2015) instead of the original Malmi and Brown-framework to allow a better comparability between the packages found by Bedford and Malmi (2015) and our findings. Whereas Bedford and Malmi (2015) used quantitative evidence to empirically find a taxonomy of five management control packages, we use the same typology of management controls as Bedford and Malmi (2015) but qualitatively investigate which management controls package is used and how this fosters or hinders ambidexterity.

3.2 Case study research

Case study research allows to investigate an empirical topic and was the preferred method considering (1) one of the research questions was the “how” question, (2) the researcher had no control over behavioral events and (3) research was done while the project was still going on (Yin 2013). A complex contemporary phenomenon, managing ambidexterity, was studied in depth in a real-world context where the distinction between context and phenomenon was not straightforward. A case study allowed to question management control practices, contextual factors that could have an influence as well as the realization of exploitation or exploitation. Furthermore a case study fits (4) the holistic management control package approach.

3.3 Selection of the case

To investigate how management controls enable project ambidexterity, an essential point was the selection of a case to do the case study. In contemporary organizations exploration and exploitation are often combined at a *project level* (Maylor, Brady et al. 2006, Winter, Andersen et al. 2006, Geraldi, Maylor et al. 2011, Liu and Leitner 2012, Eriksson 2013, Turner, Maylor et al. 2015). Projects face unique challenges so exploration is necessary to find solutions for these problems. Projects are also restricted by tight constraints (e.g. scope, time and cost) so exploitation is necessary to improve efficiency (Liu and Leitner 2012, Eriksson 2013). (1) The combined need for exploration and exploitation, makes the project management context an excellent area for ambidexterity research (Geraldi, Kutsch et al. 2011). When one is striving for both exploitation and exploration, it delivers an appropriate setting to investigate if and how the project organization is able to combine exploitation and exploration. (2) Projects are often executed by an ad-hoc project team. If a specific management control package and standardized process prove their value time and again during different projects with different objectives, in different settings and with different project teams, we do believe this contributes to both internal and external validity. (3) The limited duration of a project makes it possible to investigate the whole. In traditional companies some unnoticed preceding events can have an effect. The effectiveness of socio-ideological controls can for instance have its roots in unnoticed preceding shared successes or conflicts. Temporary projects without such prehistory allow to investigate all management controls and their effectiveness with limited risks of incompleteness.

With regard to the selected project we want to verify some terminology we will use :

Table 6: Terminology

ChemBE	Belgian subsidiary of international chemical company (ChemCO). ChemBE exists of dozens of installations.
HI	Heat integration project / capital investment project 1
DCS	Distributed Control System / capital investment project 2
IMR	Inspection, Maintenance & Repair work / regular and recurrent turnaround work
Turnaround / TAR2015	Integrated project : HI + DCS + IMR2015
EXPL	Exploitation
EXPR	Exploration
Production Plant / PlantPROD	Specific production installation where the turnaround took place
Supplier Plant / PlantSUPP	Other very large production installation at the ChemBE site which is the main internal supplier
Shutdown	Period the installation is closed to execute the turnaround work that cannot be done during operations (during the end of the detail planning, execution, and beginning of the post-shutdown)
TAR manager	Member of specialized TAR department who leads the turnaround process and the whole TAR management team.
TAR controller	Member of specialized TAR department who is responsible for cost control during the turnaround process.
TAR scheduler	Member of specialized TAR department who is responsible for scheduling of all TAR work within one integrated TAR tool.
TAR/TMS (planning) tool	Integrated schedule tool : all work activities that need to occur are scheduled serial or parallel during the planning to facilitate an efficient execution afterwards
TAR management team	TAR manager + installation management + HI/DCS/IMR managers + TAR controller + TAR scheduler ...

We contacted a very *large chemical company*, ChemCO, with the question to investigate the management of ambidexterity in one of their projects. The Belgian subsidiary, with nickname ChemBE, was one of its largest subsidiary of the multinational chemical company. Worldwide, the firm employed more than hundred thousand own staff members and had dozens of billions euros sales. ChemBE had a tightly interwoven network of dozens of production installations on an area of over multiple km², total assets exceeding half a billion euros and about thousands of employees in production, sales, research, or ancillary services.

The company proposed to focus on the execution of *large capital investment projects* in an existing plant and not on the construction of new plants. Most capital investment projects required considerable exploration. Furthermore the existing plants were bottlenecks so the capital investments needed to be executed with a minimal standstill of the plant. This could be achieved by execution during the periodic standstills during *turnarounds*. A turnaround (or TAR) project implied the entire set of activities, tools, equipment, materials, and personnel necessary in order to plan and perform all required operations, inspection, maintenance, repair and capital project work during a planned shutdown of an installation. Major activities to be executed in a turnaround included, but were not limited to : e.g. decommissioning, inspection and testing, preventive maintenance, equipment cleaning, plant specific activities as catalyst regenerations or changes, capital project execution, plant

modifications and improvements, repairs and re-commissioning. The planned interval between two shutdowns needed to be at least one year and the budget needed to exceed some percentage of the replacement value of the plant, before the shutdown was considered as a turnaround. Also important, the TAR was organized as a project! We investigated the turnaround process at one production installation of ChemBE : referred to by nickname “Production Plant” (PlantPROD). PlantPROD was the client of another larger “Supplier Plant” (PlantSUPP) at ChemBE.

Turnarounds were a normal part of the operating cycle of most installations at ChemBE. As a result, the parent company ChemCo must execute planned turnarounds on a routine basis in every region of the world. If every plant would have planned and executed its own turnarounds, this was not efficient. Turnarounds required specialized knowledge and skills. Therefore a specialized *TAR department* was set up on the Belgian subsidiary ChemBE. This department was together with installation management in charge during the preparation and execution of all large turnarounds at the Belgian site. The turnaround department had developed a strategy to achieve world-class performance in *safety, quality, cost, and duration*. In order to ensure the highest level of performance, a consistent systematic turnaround management process was considered necessary, allowing the TAR to be organized as a project. This standardized process had been optimized for more than two decades. The success of the current standardized turnaround process was illustrated by considerable reductions in turnaround durations while executing diverse turnarounds successfully time after time. Nevertheless, large capital investment projects for existing production installations in the chemical industry require considerable exploration and exploitation as well. Because the plants were bottlenecks, both exploration and exploitation were extremely important to minimize the shutdown period caused by turnaround work. Also the integration of capital project work into the normal IMR2015 work and limited allowable duration required ambidexterity. The integration of capital investment projects into existing production installations, puts tight limits requiring an optimal exploration and exploitation to minimize lost turnover. The engineering and/or construction project work occurred decentralized which often also causes considerable managerial problems. The whole turnaround process was standardized by a “turnaround project manual”. The potential high internal validity of a standardized turnaround process that had been already successful in various turnaround projects at various plants, was in favor of propositions of external validity as well.

In sum, one turnaround project TAR2015 (at “Production Plant” of the Belgian subsidiary “ChemBE”) with two capital investments projects (HI and DCS) besides the normal IMR2015-work was selected as case. To keep everything clear the TAR2015 project consisted of the HI-, DCS- and IMR2015-projects together. If we hereafter speak about the “TAR2015-project”, we point to this integrated turnaround.

3.4 Case study design and data collection

All major concerns mentioned by Yin (2013) that could inhibit hard case study evidence were handled. The deliberate case study design and data collection ensured the rigor. Qualitative empirical research requires construct, internal and external validity as well as reliability. Data collection could rely on the existing management control typology and was focused on multiple sources, a chain of evidence was established and there was proofreading and feedback by multiple contact people which together assured construct validity. Furthermore the case study protocol and development of a case study database with sound tapes, written out interviews and documents ensured the reliability of reported case study learnings. By means of pattern matching, explanation building, and active attempts to disprove earlier findings and discover alternative explanations, a strong internal validity was assured. The theoretical propositions allowed analytic generalization to lay the foundation of external validity.

We could rely on earlier research of Bedford and Malmi (2015) and ambidexterity literature (e.g. Tushman and O'Reilly III 2006, O'Reilly and Tushman 2013) for an a priori proposition (RQ1) which facilitated data collection and analysis. We focused on one unusual turnaround project with an extreme amount of exploration due to two innovative capital projects and the integration processes, which was an exceptional opportunity to study the ability of the used control package to manage ambidexterity. Each turnaround requires an optimal reuse and refinement of existing knowledge, competences and capabilities, as well as quite some development or search for new knowledge, competences and capabilities, to get the inspection, maintenance, and repair work within the tight constraints (safety, quality, time, and cost). Every turnaround, there is an active striving for exploration to push boundaries. Capital investment, however, result in higher needs for exploration. Capital investments often concern unique work for which the necessary knowledge, competences and capabilities are not fully available. Furthermore, the integration of the capital investment work in the regular turnaround work requires often new work approaches as well. Whereas each turnaround requires an ability to combine exploitation and exploration, this turnaround with a higher need for exploration allows to verify if the standardized work approach is still able to handle the combination. The unusual case made a single case study, in which we described holistically how management controls fostered ambidexterity, appropriate.

The two researchers who executed the data collection, analysis and reporting, had the necessary experience with regard to careful listening during interviews, attentive observation, inspection of documents, asking the right (follow-up) questions, adaptability, behaving neutral and ethical... Before the actual case study started the built-up familiarity with both the underlying theory, the research purpose, the overall turnaround management process as well as the selected turnaround project, allowed a firm grasp of all issues by the researchers and appropriate case study guidelines were discussed.

3.5 Data Collection process

An incredible opportunity for the case was the full cooperation by ChemBE and the TAR department. We could ask all observations, interviews, documents... we needed. The case study relies on multiple data sources, performed at different stages in the process, as shown in Table 2. All data as well as working documents were stored in one transparent database.

We had diverse orientation meetings, interviews etc. about the standardized turnaround process, the planning, scheduling and cost control tools etc. as well as the diverse turnaround projects that were going on, before picking out one very interesting turnaround project at Production Plant as case. Subsequently we observed some planning meetings and got more information for instance on the project characteristics, the TAR2015 team and the planning, scheduling and cost control tools for this specific project. We also visited the Production Plant during the actual work execution (October 2015), observed the post-shutdown review processes etc. We observed the case and could start the twelve in-depth interviews with adequate knowledge about the general turnaround project approach as well as the actual shutdown performance of the selected case. These interviews formed the core of the case study because they were used to test which management control package was experienced by the people involved in the TAR2015 project and how they perceived the effectiveness of the package.

Table 7 Research agenda

a)	March '15 - May '15	Orientation meeting : Preliminary informal contacts and formal meeting with TAR department and site management (11/05/2015)
b)	June '15	Orientation meetings about the TAR: We had a couple of explorative meetings with both TAR department and site management to get broad insights into the capital investments (HI, DCS) and the IMR work that needed to be integrated in the turnaround project. (17/06/2015 ; 25/06/2015)
c)	Aug. '15	Manual : Reading the 20-pages-summary of the standardized turnaround process manual with regard to control processes to discern the package
d)	Aug. '15	Investigation of documents (e.g. TAR scheduling tool, TAR controlling tool, TAR final reports etc.)
e)	Sept. '15	Orientation interviews : Broad interviews (2 hours) with 1 turnaround manager and 1 turnaround controller to discern the used management control package (01/09/2015)
f)	Oct. '15	Semi-structured interview : Interview (3 hours) with 1 turnaround controller about the Bedford and Malmi (2015) questionnaire to discern the package (19/10/2015)
g)	March '15 - May '16	Observation : Observation of the planning phase, execution and post-shutdown of the TAR2015-project
h)	June '16 - Feb. '17	In-depth semi-structured interviews : 12 people are interviewed to get an in-depth insight into the specific management controls applied during the TAR2015 and their effectiveness and efficiency with respect to the integration of innovative capital projects into a tight execution phase. We especially focused on how management controls foster exploration and exploitation. All interviews were transcribed, coded and analyzed.
i)	June '16 - Feb. '17	Investigation of documents (e.g. TAR2015 scheduling tool, TAR2015 controlling tool, TAR2015 final reports etc.) with regard to this specific turnaround
j)	Nov. '16 - Feb.. '17	Manual : The findings derived from all data are compared to the full standardized turnaround project process prescribed by the manual (300 pages)
k)	March. '15 - Dec. '17	Interviews, meetings, proofreading : TAR department and site management have the possibility to give feedback on the paper to validate causal explanations (Meetings : 22/02/2016 ; 03/05/2016 ; 09/06/2016 ; 11/10/2016)

The twelve people interviewed during the in-depth semi-structured interviews are listed in Table 3. We interviewed 12 people by means of a semi-structured interview (questions summarized in appendix IX.2) to fully understand which management controls were used and if these had an impact on the realization of exploration and/or exploitation (June-August 2016). We first explained the concepts exploration and exploitation before we asked by open and neutral questions if exploration and exploitation occurred in the TAR2015, which management practices contributed to this realization of exploration and exploitation and how this occurred. Subsequently the use of all different management controls was inquired, if they contributed to exploration or exploitation and again how this occurred. During the actual interview process statements were constantly questioned and compared to get more evidence or discern contradictions. Other follow-up questions were for instance if interviewees considered the used management control practices effective/efficient or would prefer alternatives, if they perceived any control practices as ineffective or even counterproductive with regard to the realization of exploration and/or exploitation, if they considered the package as a whole effective etc. The appropriateness of the package as well as the individual controls and the presence of any tensions within the package was explicitly interrogated. Preliminary findings were questioned between the researchers together and between researchers, ChemBE management and the TAR

department. Eventually the twelve interviews allowed to verify how specific management controls and the used management control package as a whole enabled or hindered ambidexterity within the turnaround project.

Table 8 Interviewed people

Function	Nickname	
Maintenance manager (PlantPROD)	Interviewee 1	I1
Head of the scaffolding department	Interviewee 2	I2
Manager production installation (PlantPROD)	Interviewee 3	I3
Headman technical automatization (PlantPROD), also project manager DCS	Interviewee 4	I4
Head of product group with affiliated installations (PlantSUPP + PlantPROD + another installation)	Interviewee 5	I5
Headmen production (PlantPROD)	Interviewee 6	I6
Project manager HI (Engineering department)	Interviewee 7	I7
TAR controller (TAR department)	Interviewee 8	I8
Headman mechanical work (PlantPROD)	Interviewee 9	I9
TAR manager (TAR department)	Interviewee 10	I10
TAR planner (TAR department)	Interviewee 11	I11
Headman assets (PlantPROD)	Interviewee 12	I12

The processing of the interviews occurred both quantitatively and qualitatively. First, the 12 interviews were verbatim transcribed, uploaded and analyzed in NVivo. A coding structure was developed for the 6 management control categories and 22 management controls, as well as for the exploitative and explorative outcome. Larger text blocks which pointed to the realization of exploitation and/or exploration were coded accordingly. Smaller text blocks which pointed to specific management controls that stimulated the realization of this exploitation and/or exploration were also coded. When all interviews (over 300 pages) were coded, these were analyzed by queries. The search queries linked the number of times the 6 management control categories and 22 management controls within the 6 categories were linked with exploitation and/or exploration. Using this quantitative analysis we thus first identified which management controls were often linked with ambidexterity at the project level, without specification of the way a management control is used.

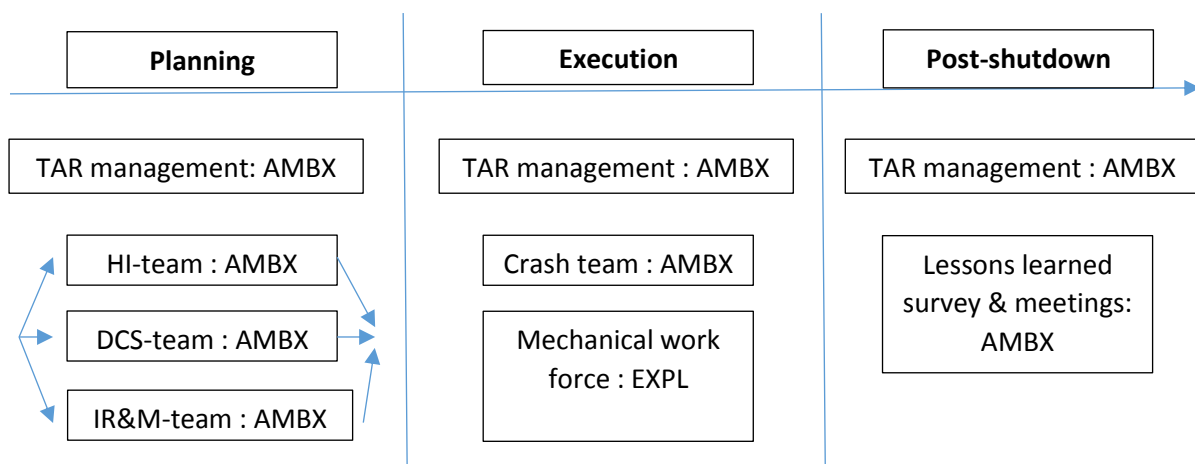
In a second step we used our extensive qualitative interview data to understand and describe how the used management control package contributed to achieve exploitation and exploration. We constantly compared the findings during interviews with information from diverse documents. Eventually we also compared the observed package and effectiveness, with the package and intentions described by the standardized manual. The univocal statements by the diverse interviewees, in line with the observations as well as underlying documentation such as the manual, and the useless efforts to find deviating opinions, made it straightforward to converge the case study results.

IV. Case background

Standard turnaround project cycle

We mainly focused on the three broad phases (planning, execution and post-shutdown) but in fact the turnaround process consisted of six phases : the strategic, conceptual, basic and detail planning phase, an execution phase and a post-shutdown phase. Turnarounds are planned in the conviction that elaborate planning activities contribute to a safe and successful execution. Strategic planning implies previous lessons-learned and business objectives should be considered on a continuous basis apart from any specific TAR project. Each specific project requires a period of intense TAR planning which starts with conceptual planning, to be further elaborated in a basic planning and eventually into a detail planning. During the conceptual planning high level aspects of the specific TAR project are defined. These concepts from the conceptual planning are further developed during the basic planning into manageable work processes which define in detail how more precise planning will be executed. During the detail planning phase, the execution is prepared accurately. Towards the end of the detail planning phase, some defined pre-shutdown jobs (e.g. some inspections, tie-ins, etc.) should be completed to avoid pre-shutdown work overflow. De-commissioning begins during the pre-shutdown (detail planning), but continues during the shutdown (execution) and ends somewhere within the shutdown window. Thereupon the plant is de-inventoried, all equipment is cleaned sufficiently to ensure safe working conditions, electrical sources are de-energized and the facility is isolated from its surroundings according to the detail plan. After completion of all turnaround scope, including capital work tie-ins, the installation can be re-commissioned, systems shall be re-energized, the process systems are checked for readiness, and the facility is returned to operations. The final phase of a turnaround project is the post-shutdown phase. During this phase, work not completed during the shutdown must be finished (e.g. remaining re-commissioning, insulation, removal of scaffolds), the turnaround workforce and contractors are demobilized, temporary infrastructure is removed and the site is cleaned up. The performance of the overall TAR project is evaluated during the review meeting(s). Any necessary action items are distributed to the appropriate individuals within the organization for follow-up. Furthermore lessons learned are collected and all documentation related to the TAR project must be completed, distributed and archived during this phase, including the final TAR report, to be available for the next TAR project cycle. After all invoices are collected and paid, the turnaround project is officially closed.

Figure 8: TAR2015



TAR2015 project

The turnaround project we followed, was planned to be executed in October 2015. It comprised besides considerable regular inspection, maintenance & repair activities (IMR2015), also two large capital investment projects (HI and DCS).

Regular **Inspection, Maintenance and Repair activities (IMR)** form the recurrent part of each turnaround project. Nevertheless IMR-work also differs each time : IMR-scope is partly recurrent (e.g. legal inspections) but ageing installations and increasing safety and environmental requirements for instance cause new IMR scope as well.

Diverse IMR requirements cause a shutdown which is in fact undesirable. *“In an ideal world a plant would be started to never stop once it is built. (...) There are plenty of reasons why this is impossible. The frequency of the investigated turnaround at PlantPROD depends on the lifetime of the catalysts. Replacement of a catalyst requires a shutdown every 18 to 24 months. But then all other work that should occur during a shutdown, is planned during the shutdown to optimize plant utilization. Likewise mandatory inspections or maintenance of diverse wear and tear, need to occur.” (I1)*

The shutdown for the IMR2015-work was used to execute two large capital investment projects which needed a multiple-weeks-standstill of PlantPROD.

The **heat recovery project (HI)** was the first large capital project. As a means to energy saving, a large, complex and innovative heat recovery project was initiated. The plant had a considerable by-product of steam. The recuperation of the heat of this steam could be used for energy generation. The HIP was described as follows: *“The heat integration project was innovative. It is not at all something you can buy from the shelf! Own company people came up with the idea and had to develop it. Furthermore it had a considerable impact on multiple components of the existing PlantPROD and it had to be constructed within tight time limits.” (I1)* The planning preparation took multiple years and was done by the specialized engineering department who could rely on a Project Operations Manager (POM) who served as point of contact within PlantPROD. The mechanical work to build in the heat recovery equipment into PlantPROD, needed to occur in different critical aspects of the PlantPROD. Like this the heat recovery project intervened in different main processes and brought about a considerable shutdown scope that needed to be prepared and integrated with the IMR2015 and DCS scope into one detailed TAR2015 planning by the end of the planning phase.

The **complete renewal of the distributed control system (DCS)** was the second large capital investment project. *“The distributed control system (DCS) or process light system (PLS) was the operating system of the whole plant and included the hardware and software to control the manufacturing plant. Some suppliers do offer the hardware. But the application program with the software that guides PlantPROD’s process is firm specific and programming needed to start from scratch. The previous steering system was in use since the construction of the plant in 1993, and would from 2018 on no longer be supported by the supplier. Therefore, the system needed to be renewed.” (I1)* The replacement was prepared by a team of “Production Plant”-personnel and a specialized outside firm. This innovation of distributed control system was also closely interwoven with other aspects of the turnaround considering every single function in the installation was controlled by the system.

Minimizing the turnaround’s shutdown window within safety, quality, time and cost restrictions was the most important objective for the shutdown. Safety and quality restrictions were simply indisputable. Time and cost restrictions had a strong impact on the installation’s profitability. Each day of standstill PlantPROD lost €150.000. Nevertheless, if the turnaround execution felt behind, another €750.000 was lost by PlantSUPP. *“The closed PlantPROD buys semi-finished products from another*

installation PlantSUPP at ChemBE and delivers their own production, i.e. finished and semi-finished products, to other plants at the site. This interrelatedness with other manufacturing plants, causes considerable limitations.” (15) Each day the planned shutdown was reduced, profits increased thus by €150.000 for PlantPROD. Each day the actual shutdown felt behind the planning, PlantSUPP lost €750.000 and PlantPROD lost €150.000. In sum each day of shutdown delay, more than € 900.000 was lost : at least € 750.000 a day at PlantSUPP and € 150.000 a day at PlantPROD.

The success of the TAR2015 thus depended on an accurate and coordinated planning. Ideally, the shutdown was planned as short as possible but a *realistic planning* was necessary to enable a smooth coordination of interrelated jobs and to prevent any delays. The objective was not only working as fast as possible but “*planning all jobs accurately and executing the turnaround exactly as planned*”. (15) All scope needed to be integrated and modelled into one schedule. One tried to make this planning as accurate as possible to enable a coordinated workflow.

TAR2015 performance

During the TAR2015 the team needed to explore new work methods and work paths to guarantee an integrated turnaround planning of capital projects and normal IMR2015 project execution within safety, quality, time and cost restrictions. The initial detail planning revealed a shutdown of seven weeks. Extensive efforts and new breakthrough ways of planning and scheduling (new best practices) led to a reduction to five weeks. Nevertheless, the actual project execution passed flawlessly. One succeeded in executing the detail planning exactly as intended without safety incidents, within time and within budgets. Furthermore far less quality issues were noticed than expected, so testing demonstrated far less rework than usual and the restart of the installation with the new operating system went excellent from the first time on.

V. Results

5.1 Quantitative relevance of management controls when realizing ambidexterity at the project level

In Table 4 we give an overview of the number of quotes that were mentioned during the interviews for the different categories of management controls: strategic planning, measurement, compensation, structure, policies and procedures and socio-ideological controls.

Table 9 “Nvivo 1” Management control categories used at the TAR project level.

Construct	# interviews	# Quotes	Exploration		Exploitation	
			# interv	# Link EXPR	# interv	# Link EXPL
Exploration	12	375				
Exploitation	12	921				
Strategic planning* ₁	12	55* ₁ * ₂	5* ₁	9	12	32
Measurement	12	501	12	99	12	316
Compensation	12	117* ₃	11* ₄	22	12	76
Structure	12	443	12	155	12	237
Policies and procedures	12	703	12	172	12	433
Socio-ideological	12	489	12	128	12	266

*₁ Not everyone was included in the strategic planning process. This explains the low level of quotes. Furthermore the low level of quotes is also because only 2 management controls are under strategic planning (mode and participation). Nevertheless, the people who were involved considered strategic planning very useful for both exploitation and exploration.

*₂ The total number of quotes e.g. 55 for strategic planning, is not equal to the sum of times a statement about the accomplishment of exploitation was linked with strategic planning (32) and the sum of times a statement about the accomplishment of exploration was linked with strategic planning (9) whereby 32+9=41. This is logic because one statement of exploitation or exploration, can contain multiple quotes coded as strategic planning. Furthermore it is possible that a quote is not linked to the realization of exploitation and/or exploration.

*₃ Compensation is about attaching (financial) rewards and/or compensation to achievement of goals. The use of performance based compensation was rather limited in the case. Furthermore there is a cultural reserve amongst Belgian people to not talk about compensation.

*₄ TAR2015 Controller was exceptionally a contractor who had worked exclusively for the TAR department for multiple years.

All 6 control categories were mentioned by all 12 interviewees. The third column “# quotes” shows per category the total number of times a specific management control in that category was mentioned. Column four shows for each control category the number of interviewees that associated the category to the achievement of exploration. Column five indicates the number of times the control category during the interviews was associated with exploration. Columns 6 and 7 show the same information with regard to exploitation. We can see that all control categories matter when striving for exploration and exploitation. All twelve interviewees mentioned 921 times an example of exploitation. Overall policies and procedures (703 times noticed) were linked with the realization of both exploitation (433) as exploration (172). Measurement (501 quotes) was also mainly linked with exploitation (316) but with exploration as well (99). Surprisingly between these control categories typically expected in bureaucracies, socio-ideological controls (489 times mentioned) were also often linked with both exploitation (266) and exploration (128). Structure (443) was another highly influential category of management controls fostering both exploitation (237) and exploration (155). Compensation (117) was not mentioned that much. There were only 76 links with exploitation and 22 with exploration. Strategic planning (55 times mentioned) was linked again with both exploitation (32) and exploration (9). The very low number of links was because the category includes only 2 management controls and only a number of interviewees were involved in the strategic planning process. The ones who were involved (n=3 intv.3 , 5 and 10), confirmed that strategic planning was important for both exploitation and exploration. This analysis reveals that all 6 control categories mattered in fostering ambidexterity.

Table 10 gives an overview of the specific management controls used during the TAR2015 project together with the number of times these were mentioned by the interviewees, the number of interviewees who associated the controls to the achievement of exploration and exploitation, and the number of times the associations occurred.

The table enables to indicate which specific *management controls* were most often *connected with exploration and/or exploitation*. Policies and procedures were associated with the realization of exploitation by pre-action reviews (235), standardization (171), boundary systems (85) and autonomy (46). The measurement controls most often associated with the realization of exploitation were respectively interactive measurement (133), cost control (98), diagnostic measurement (79), tightness (52) and measure diversity (37). The mostly mentioned socio-ideological controls were socialization (131), social control (94) and selection (72). With regard to structural elements of control were integrative liaison devices (98), communication (85), the level of decentralization (59) as well as the level of hierarchy (55) often associated with the realization of exploitation. Furthermore performance pay is often linked with explanation (60), but in fact only staff members and contractors get performance pay at ChemBE which can explain the low number of associations.

The realization of exploration was most often associated with policies and procedures (172), structure (155), socio-ideological controls (128) and measurement (99). Now we see that the main policies and procedures associated with exploration were pre-action reviews (80), boundary systems (56), autonomy (46) and standardization (44). The mostly mentioned structural controls were socialization (76) and social control (46). Again a varying level of decentralization (57), integrative liaison devices (51) and (organic) communication (50) were also often associated with exploration. The influence of measurement controls on exploration was mainly linked with interactive measurement (53) and cost control (35).

This analysis reveals that at the TAR2015 project level a wide variety of specific management controls was associated with the achievement of exploration and exploitation and that, not consideration of individual controls, but **a control package approach** was preferable to study management of ambidexterity.

Table 10 Management controls used at the TAR project level.

Construct	# interviews	# quotes
Exploration	12	375
Exploitation	12	921

Construct	# inter	# quotes	# inter	# Link EXPR	# inter	# Link EXPL
Strategic planning	12	55	5	9	12	32
Mode	12	32	5	8	12	24
Participation	12	23	3	3	12	18
Measurement	12	501	12	99	12	316
Diagnostic	12	89	7	15	12	79
Interactive	12	172	11	53	12	133
Tightness	12	60	4	13	12	52
Cost Control	11	133	9	35	11	98
Measure Diversity	12	46	5	10	12	37
Compensation	12	117	11	22	12	76
Performance Pay	12	78	10	19	12	60
Subjective/Objective	7	14	1	2	7	12
Short/Long Term	12	25	2	3	12	22
Structure	12	443	12	155	12	237
Decentralization	12	105	12	57	12	59
Hierarchy	11	73	10	28	10	55
Communication	12	118	12	50	12	85
Integrative Liaison Devices	12	126	11	51	12	98
Policies and procedures	12	703	12	172	12	433
Autonomy	12	79	10	46	12	46
Boundary Systems	12	120	12	56	12	85
Standardization	12	193	12	44	12	171
Pre-action Reviews	12	311	12	80	12	235
Socio-ideological	12	417	12	128	12	266
Selection	12	81	6	23	12	72
Socialization	12	180	11	76	12	131
Belief Systems	11	38	5	12	11	29
Social Control	12	117	11	46	12	94

5.2 Qualitative analysis : Which management control package was used to realize ambidexterity at the project level?

We quantitatively retrieved from the 12 in-depth interviews that ambidexterity required a wide package of management controls. Subsequently we qualitatively scrutinized all transcribed interviews to disentangle the characteristics of used management controls. We also relied on the standardized turnaround process described in the manual, direct observations, physical artefacts, inspection of diverse documents and other interviews to describe clearly the actual control practices.

We noticed a very high internal consistency without deviating statements, revealing a **hybrid management control package** effectively fostered ambidexterity in the TAR2015. The observed package was characterized by a strong use of policies and procedures, a high reliance on measurement and socio-ideological controls and great emphasis on strategic planning. Often recurring management control practices were the highly standardized turnaround process and pre-action reviews, tightly emphasized accountabilities to a wide variety of metrics, tight monitoring and steering, delegated decision authority, use of strict boundary systems, varying discretion in conduction of work activities, combination of organic and mechanistic communication patterns, high use of lateral integrative devices and moderate reliance on monetary compensation systems.

Now we will describe how the different management controls of the observed hybrid management control package were used during the planning, execution and/or post-shutdown phase of the project in order to foster exploration and/or exploitation. This allows to observe fluctuations in the use of management controls throughout the turnaround project cycle. Because management control handles influencing of behavior, we illustrated with diverse quotes whether and how diverse management controls were perceived effective by the workforce.

5.3 Qualitative analysis : How was the management control package used in realizing ambidexterity at the project level?

1. Planning phase

Policies and procedures were very important to foster **exploration** as well as **exploitation** during the planning phase. *“The TAR department has actually a certain system, a certain approach, that enables to execute a turnaround in an efficient and safe way.” (I4)* This “Turnaround Management Process” manual was the governing procedure to be used for the management of the turnaround projects (TAR) worldwide. It implied a high level of rules and procedures specifying the means of conducting planning, execution and post-shutdown (high level of **standardization**). The procedure defined the requirements and guidelines and supported the user in effectively managing turnarounds in order to achieve the highest performance regarding: safety, reliability and plant integrity, schedule and cost. Also capital project teams relied on the same type of standardization during the planning process.

Strategic planning was a formalized, deterministic and deliberate process (**mode**) with a **participation** of a limited but diverse group. *“Management of the installation decides the duration between two shutdowns. Of course they do not know all constraints and therefore there is a core team that synchronizes all installations’ turnarounds at this site. The core team for the site shutdown planning comprises the different managers of each installation, the heads of each product group, some managers of functional departments and of course the manager of the turnaround department and one TAR controller. The COO of the site is in charge of this planning process and the goals are to coordinate the shutdowns of interdependent installations while spreading the workload of the diverse turnarounds considering the limited (specialized) resources.” (I8)* **Strategic planning** fostered **exploitation** by (1) minimizing the costs of shutdowns as well as standstills. The interval between two

turnarounds was determined by the operational and legal lifetime of the used catalyst which varies from one and a half to two years. This implied that all repair work, legal inspections etc. necessary to keep the firm producing during the one and a half to two years between the upcoming catalyst substitution and the next one, needed to be considered. All necessary (shutdown) work between the first upcoming turnaround and the next one was planned into the upcoming shutdown so that no shutdown was necessary between the two upcoming turnarounds and the firm would be able to produce at least without standstills till the next time the catalyst needed to be switched. Furthermore (2) the lessons learned and TAR documentation from diverse TAR projects were considered to allow the reuse of earlier acquired knowledge and capabilities.

Strategic planning allowed **exploration** through (1) the use of lessons learned to identify areas with major potential and need of improvement with regard to the turnaround process or installation and (2) a timely initiation of small improvements, larger innovative (capital) projects or turnaround process changes.

Innovative ideas originated bottom-up during daily operations or during the lessons learned processes of earlier turnarounds. There were strong **belief systems** that triggered innovation. Non-staff members were also triggered by a *bonus (performance pay) for innovative ideas*. Employees initiated the idea for the HI-project. *"The idea for the heat recovery of steam was initiated by some plant personnel."* (I9) Own plant personnel then initiated first planning (**pre-action reviews**) and profitability checks (**cost control**) *"Process improvement people of the own plant made an initial study and studied the potential economies by recuperation of this steam."* (I9) Subsequently the central headquarters (**centralization**) executed further preliminary planning (**pre-action reviews**) and profitability checks (**cost control**). *"The process improvement support department of the headquarters further investigated the idea. Because of the low pressure of the steam, a big apparatus was necessary. First cost estimates revealed a total cost of more than 10 million euros (including the opportunity costs of a 5-weeks shutdown were normally 3-4 weeks suffice)."* (I9) *"The profitability requirements (boundary systems) seemed fulfilled according to the commission at the headquarters responsible for all investment decisions, so a more elaborate project preparation was started."* (I9) The in-depth planning (**pre-action reviews**) was done by a specialized team (**decentralization**) who got some **autonomy** but also involved other specialized departments (**integrative liaison devices**). *"The whole project was attributed to an engineering team at the own business site that needed to plan the project, involve other necessary departments (e.g. construction), and follow up the execution."* (I9)

The distributed control system project implied that the whole system, including the inputs and outputs, were replaced. Besides all wires, also the whole programming needed to be developed from scratch (**exploration**). Any wire that would be connected wrong, could obstruct to restart the plant. Furthermore the user interface needed to be worked out, tested, and taught to all employees.

The project could be initiated some years in advance because it was known that the supplier support would end in 2018. Five years before the actual turnaround, in 2010, the first actions for the replacement were initiated. From 2012 on, 3 years before the actual execution, a real DCS project team was formed (**decentralization**) with installation personnel, specialized departments and an external supplier of hardware and software (**integrative liaison devices**). Previous experiences and lessons learned (**exploitation**) from the replacement of the DCS in another plant indicated considerable start-up problems and installation standstills afterwards despite extensive planning on before. Additional preparation and testing (**pre-action reviews**) needed to further reduce such troubles this time. Furthermore it also created the necessary goodwill (**socialization**) among installation staff to contribute to a good implementation. Some operators who had worked with the old operating system for more than 20 years, now needed to adapt themselves to a completely new steering system in a

couple of days to eventually successfully restart the plant. *“To involve all operating staff, a member of each team was asked to be involved in the development of the new operating system. These people can give their remarks, ask for additional features, but were also asked to discuss the current model from time to time with their own team. Like this every operator is involved in the planning process to overcome resistance to change. Furthermore all measurements were tested by means of a simulator. These tests took half a year : from October 2014 to April 2015.”*(I6)

IMR2015-work largely existed of recurring work. One could thus rely on preparations of earlier turnarounds at the same installation. *“Each 18 to 24 months we have a turnaround at PlantPROD. You don’t need to rediscover common knowledge time and again.”*(I1) The library (**standardization**) of the **TMS-tool** was mentioned as a critical means for **exploitation**. *“We do have a library in the TAR planning tool. For many jobs, we can pick the work preparation of earlier turnarounds from that library, control the appropriateness, change or update certain aspects (e.g. because of interrelations with the capital project work) and reuse it. That’s much faster than starting from scratch.”*(I11) Knowledge and capabilities build up during earlier turnarounds were stored in the library for reuse and newly explored knowledge and capabilities could be stored as well. The standardized TAR process (**standardization**) required that pre-action reviews for the TAR2015 were again prepared in the TMS planning tool to ensure planning work could be re-used for other TARs or similar shutdown items. Policies and procedures thus enabled to “exploit” what was explored earlier.

After the strategic planning phase, the planning of IMR-work and capital projects (HI and DCS) was further elaborated during the conceptual, basic and detail planning phases (**pre-action reviews**) by decentralized project teams (**decentralization**). The HI-, DCS- and IMR2015-teams got quite some **autonomy** to prepare the actual execution (**pre-action reviews**) within safety, quality, time and cost limits (**boundary systems**). Nevertheless, the overall planning, execution and post-shutdown processes of the turnaround were quite formalized in the TAR manual (**standardization**). The TAR management team (**integrative liaison device**) was responsible to follow-up the project teams their progress. During this early conceptual planning they stimulated project teams to elaborate innovative ideas while they still had the flexibility to change scope. *“Turnaround projects are done according to certain systematics. The turnaround process is standardized and formalized. Nevertheless, we still allow flexibility (autonomy) but within a set down process (standardization). Flexibility has its time and space, afterwards the moment is gone. Also innovation has its moment. You need to unite people (integrative liaison device) and give them the time and space (autonomy) and communicate clearly the objectives (mechanistic communication). In our firm we know this will result in solutions.”* (I8) The importance of timely pre-action reviews for exploration recurred during other interviews as well. *“Innovation is enabled because there is not such a big time and cost pressure (as during the execution) (lower boundary systems) during the planning. People can prepare the shutdown in an unstressed atmosphere and do get the time to consider opportunities and to discuss them.”*(I5)

The procedure proposed best practices, but it was the task of the TAR core team to describe how these would be applied to their specific TAR project. So besides **standardization**, the procedures left each team considerable **autonomy** during the planning to (1) pick out most appropriate best practices, (2) to fill in how these would be applied and (3) to elaborate preparations for processes/deliverables that were not described in full detail. Autonomy was mentioned to allow reuse of existing knowledge/capabilities (**exploitation**) as well as to come up with innovative solutions when opportunities were spotted or stringent circumstances forced them to discover new alternatives (**exploration** and **exploitation**). *“Autonomy more often leads to innovation than working within a very strict work organization.”*(I2)

Selection, socialization, belief systems and **social control** were all important to achieve the dedicated people necessary for **exploitation** and **exploration** within the TAR project organization. Almost each interviewee mentioned “the right people” as the single most decisive turnaround success factor. The **selection** of employees for (the planning of) the turnaround, seemed to occur according to a set of criteria such as value alignment, technical competence and attitudes. Also experience was valued. *“Our installation has regularly turnarounds, and we select people for core jobs who performed well during earlier turnarounds. These ones have the urge to perform well and form a basis of continuity, the new ones are then pulled into synchronism.”*(I3) It already illustrates how **selection** enabled **social control**. The company culture allowed to rely on shared values, norms and beliefs to direct work activities (**social control**). Every interviewee immediately mentioned safety, quality, timing and cost as the four most important measures for the turnaround and each of them was really convinced about the importance of respect, open communication, collaboration, dedication to top performance etc. for the successful completion of this turnaround. The reliance on shared values and norms directed employees’ behavior towards a combination of **exploration** and **exploitation** when they got considerable autonomy during the planning. Shared values, norms and beliefs directed work activities in line with safety, quality, timing or cost goals (**exploitation**). Furthermore the culture allowed **exploration**. *“A strong team results in innovation because of the openness and the mutual trust. The company culture also allows innovativeness.”*(I5) *“We just have a culture where someone can propose innovative things.”*(I5)

Social control of **exploration** and **exploitation** was also often linked with **socialization** and **belief systems**. *“We stimulate a real sense of responsibility, ownership, commitment, and awareness of expectations and feasibility. You need to create a healthy result oriented culture, and the pride to strive for the best”.* (I8) Even team-orientation was stimulated. *“People try to distinguish themselves by making a difference. But we make them also aware that egocentric behavior is not appropriate because they cannot succeed on their own so they do need the team. Everything needs to occur in control and safe, safety is priority one.”*(I8) **Socialization** was done by means of induction programs, social events... **Belief systems** contained diverse formal trainings, statements or posters on every wall that conveyed basic values and premises for action, TAR objectives schemes that spread EHS, quality, shutdown window and cost targets, sharing diverse (formal) documents/reports and the TAR project execution plan to stimulate common understanding of and alignment by the stakeholders on critical project issues... Training and development processes were used when providing information alone was not perceived sufficient to align people involved in certain aspects of the turnaround,. This was especially true for the EHSQ Management theme which described all activities and deliverables concerning environment, health and safety as well as execution quality assurance, quality control, and inspections. But also with regard to other aspects the preparation of the organizational chart for the shutdown during the planning allowed that all staff could be trained for the turnaround. Training programs ensure knowledge transfer and comprehension as well as employees’ involvement.

Management stimulated this culture. **Interactive measurement** and **socialization** can go hand by hand in case of a good TAR manager (**selection**). *“The leadership capabilities and experience of the TAR manager contributed considerable to the successful turnaround. The selection of the TAR manager is very important for a successful turnaround. We often see how results are linked to a certain TAR manager. A TAR manager needs to guide towards an optimal balance of exploration and exploitation to be successful. He needs to leave some openness, but also needs to integrate and challenge to foster both innovativeness and efficiency.”*(I5)

There were a surprisingly **low** (+/- 10% for staff members) or **no** (non-staff members) **performance pay** which was perceived highly effective by all interviewees. *“Yes, staff members do have performance*

pay which is partly based on the successful turnaround. But I am convinced that even without the performance pay, the result would be the same. Everyone really want to perform well. You mention performance based incentives, but you also have satisfaction and appreciation which is not easily quantifiable but much more influential than performance pay.”(I8) They felt themselves driven by a shared culture (**socio-ideological controls**) that stimulated a combination of **exploitation** and **exploration** in the firm’s best interest and feared more performance pay and tighter targets would cause too much focus on exploitation to achieve targets and obtain financial incentives.

Individual compensation for staff members was determined in an **objective** way, rewarded both **short term** (exploitative) and **long term** (exploitative and explorative) objectives and was mainly linked to *exploitative targets* with regard to safety and efficiency.

Staff as well as non-staff employees were convinced that too stringent targets would not be effective at all because it would harm collaboration and let people focus exclusively on exploitation. The targets were difficult to achieve individually, but easily achievable by means of a good collaboration so this interdependence pushed the individual staff members to collaborate and to serve the overall interests while leaving enough autonomy to combine *exploitation* and *exploration* according to what they perceived in the best interest of the firm.

There was a combination of decentralized project teams (**decentralization**) who got the **autonomy** to combine exploration and exploitation while preparing the project work and a centralized TAR management team (**centralization** in an **integrative liaison device**) who ensured planning progress according to the TAR manual and efficiency. *“Decentralization is necessary because the nature of work differs. Project people are only focused on the capital project, all necessary engineering, materials and other preparations, but they do not consider other work. TAR people consider the whole and integrate to ensure an efficient shutdown.”(I1)* **Decentralization** was an efficient way to let project teams (**integrative liaison devices**) with specific knowledge, skills, experience, values and mindsets (**selection**) estimate and prepare the scope for the turnaround work efficiently (**exploitation**). For other tasks, they needed to explore new possibilities but again their build-up knowledge enabled them to generate new knowledge appropriate to handle challenges not solved adequately before (**exploration**). *“I do think decentralization fosters innovation considering the knowledge of different people who are specialist in their own field.”(I8)* Nevertheless, decentralization and autonomy were always combined with clear boundaries or acceptable domains of activity that indicated safety, quality, time and cost restrictions (**boundary systems**). *“We do have a kind of limited, controlled, freedom. You do have freedom to take initiative, but you need to stay within certain restrictions”(I4)* These limitations forced project teams to stay within the acceptable domains of activity and to work efficiently (**exploitation**) and to be innovative (**exploration**) if current knowledge and skills were inappropriate to stay within these limits.

Measurement and performance target setting were pro-actively used to control results and behavior. Overall measurement focused on four financial as well as non-financial performance measures (**measure diversity**): safety (EHS), quality, time and cost. This focus is broadly shared considering all interviewees immediately mentioned these four as core measures. Nevertheless, uncertainty made it hard to set very strict subordinate performance targets and to base subordinate performance evaluations on them. A **mediocre level of tightness** forced the planning team to work efficiently (**exploitation**) but still left autonomy which allowed exploitation within tight boundaries and left the necessary autonomy for **exploration**.

The TAR management team used both **diagnostic** and **interactive measurement** to follow up **tightly** and on a regular basis the individual and collective planning progress. *“The TAR management team*

organized meetings on a regular basis to compare the intended planning progress with the actual progress. These follow-up activities were more strict. In case of problems the management attention enforced priority. Because your project team is part of the TAR organization, and everyone is aware of the importance of turnarounds, you can work with a higher focus and intensity to obtain the project objectives.” (I7) **Interactive measurement** allowed the management team to stimulate creative behaviors and to address strategic uncertainties. Like this interactive control patterns fostered **exploration** during the planning. Besides safety, quality, timing and cost were questioned by top managers as well as (independent) experts during every planning meeting and also during informal contacts which stimulated **exploitation**. A constant debate was thus a means for managers to encourage subordinates to combine exploration and exploitation during the planning. Also **diagnostic measurement** fostered **exploration** and **exploitation** considering management monitored all deviations from the historical best practices with regard to safety, quality, timing and cost. Safety and quality standards were not open to discussion. Any deviation between planned and best practice performance led to immediate additional **exploitation** and **exploration** to come up with adequate solutions. If the planning tool indicated that cost or scheduling objectives could not be met, these deviations from preset standards of performance also led to additional discussion and mostly to more **exploration** or a better use of **exploitation**.

All interviewees agreed that the complexity of the three projects required a timely and extensive planning (**pre-action reviews**)! The integration of capital projects into the overall planning was considered important for project success. “Any turnaround failure worldwide is mostly caused by a bad management of the capital project impact.” (I5) The interview data also revealed that the planning activities needed to be highly integrated (**integrative liaison devices**). Integration was done by development of a single cross functional TAR project organization (**integrative liaison device**), and an integrated TAR project schedule (**integrative liaison device**). “The IMR2015-team is responsible for the planning of the IMR2015 work. The HI and DCS project teams are responsible for the planning of the capital project work. The integration of IMR2015 and project work is the responsibility of the TAR department. The TAR department has the tool that allows to schedule in a way the permissions for a certain task are released at the right moment when the execution takes place.” (I8)

The **structure** changed during the planning which contributed to both **exploration** and **exploitation**. The locus of authority was initially decentralized among the IMR, HI and DCS teams (**decentralization**) but then it was increasingly centralized at the turnaround management team level (**centralization**). The integration process was entrusted to the experienced specialized TAR department (**selection**) who was in the lead (**centralization/hierarchy**). “The TAR department has a top-down controlling function.” (I7) “The TAR department its knowledge is the efficient organization of the turnaround, the coordination of diverse departments and the integration of the whole.” (I4) They made they had the knowledge and capabilities to combine efficiency and innovation. “The turnaround unit is asked to lead the planning integration considering they are specialized to handle the integration process. They immediately set some time constraints, require timely planning updates and follow-up the planning progress. Furthermore, they use for instance the turnaround challenge mechanisms also to enable a smooth project integration.” (I5) The **interactive measurement** and **standardization** of turnaround processes by the TAR management was really appreciated by the project teams as well: “TAR management stimulated the integration of the project into the turnaround. Furthermore their manuals offered useful guidelines and they stimulate knowledge exchange during the planning by their coaching and challenge mechanisms.” (I7) The TAR mgt. team was led by the TAR manager and the plant manager. “It is more efficient to leave the lead to a TAR manager who has most experience with management of turnaround projects. An installation manager is more focused on daily operations of the installation.” (I8)

Integration was by all interviewees linked with **communication**. The TAR process (**standardization**) required careful planning of **communication** by means of communication plan, a documentation plan and a meeting plan to avoid misunderstandings and ensure smooth cooperation. The communication plan ensured that the relevant people got the right information in a timely manner. There was a free flow of important information throughout the project teams. The documentation plan ensured a document management system, definition of the documentation structure, definition of access-rights for the relevant members and the definition of the origins and sources of the relevant information of the TAR. Regular periodic reports of TAR projects summarized the status of the TAR project and capital projects by containing measurable performance indicators combined with a short description of any risks and concerns that should be highlighted. The meeting plan scheduled weekly or bi-weekly jour fixes during the whole planning which were regular working meetings.

We noticed a **mechanistic communication** pattern in which **organic communication** was enabled. If the right people got the right information (e.g. knowledge and capabilities) than they could reuse and optimally exploit previously explored knowledge and capabilities. Management also delegated some decision making because they were dependent on subordinates for their information. Organic communication fostered both **exploration** and **exploitation** because a flat **hierarchy** and free flows of information allowed everyone irrespective of their position to bring in their knowledge and capabilities (exploitation) or question the need for additional exploration. *“People need to be enabled to participate and contribute in a positive way, regardless their hierarchical position. They must be allowed to speak without being interrupted by others, irrespective of these others hierarchical position. One needs to listen irrespective the way it is said. It is the content, the message, that matters. Something (innovation and efficiency) arises if you can create the feeling that people are respected and others listen.”*(18) Employees indicated they were strongly motivated by a common drive and sense of responsibility (**social control**), and perceived the tight follow-up (**tightness**) as a necessity for success and not at all as a way to blame people : *“There is a search for solutions, not for culprits. Looking for culprits would be the wrong direction! We are team-oriented from the absolute conviction that individuals cannot achieve what teams can.”* (18) It also illustrates that the team orientation (**integrative liaison devices**) was much more important than individual **tightness**. Teams (**integrative liaison devices**) united experience and knowledge and likewise enabled both **exploration** and **exploitation**.

One very important aspect for the integration was the integrated planning tool. *“The standardized tool fosters efficiency.”*(15) Scope collection during the planning ensured that all TAR related scope (maintenance, operations, capital projects, etc.) was integrated into a single integrated scope list or database. Then scope synchronization ensured that all TAR scope items were analyzed to avoid scope redundancies and detect overlaps. Three cross-functional teams (HI, DCS and IMR2015) drew from the same resource pool and shared common contracts, services... An integrated planning (**integrative liaison devices**) allowed a more (time-) efficient planning, optimal safety and an optimal resource allocation resulting in savings in contractors, logistics, infrastructure, labor and material expenses (**exploitation**). Besides **exploitation**, the timely integration also indicated planning incompatibilities where more **exploitation** and/or **exploration** was necessary. *“Despite it would have been easier for the project team to keep the scheduled project out of the integrated TAR tool, it was the integration of project activities into an integrated planning that enforced to further optimize.”*(15)

The scope freeze (**boundary systems**) and the scope challenge (**interactive measurement**) were two important elements of the pre-action reviews. Scope freeze was the commitment to collect/develop all scope in time. The scope collection process for IMR work is highly standardized. *“Despite the maintenance scope will always be somehow different, a turnaround without any projects can be almost*

*standardized.” (I1) In this case the main scope was the IMR2015 scope, and the scope of the two capital projects (HI and DCS). “Project scope needs to be delivered by the project management team.”(I8) A scope freeze needed to occur before the end of the basic planning at least 8-12 months before the shutdown. It formalized a commitment between all members of the TAR management team and the scope coordinator that the scope was collected in time to promote subsequent development and job planning. Significant scope changes, excessive small changes and pre-shutdown scope overflow after scope freeze can be a major cause of project failure because they make it impossible to plan work in an effective way. This was mentioned to lead to inefficient shutdown execution with increasing TAR costs and shutdown duration. Nevertheless, scope changes can occur due to late scope that could have been noticed earlier, additional repairs unknown at scope freeze and pre-shutdown scope that is not completed in time. Between the scope freeze date and the start shutdown milestone, the scope change management process (**standardization**) provided an effective workflow to document, control and approve these changes. Again this was an example how previously experience that forced exploration led to knowledge and capabilities which got integrated in the TAR manual. An important remark concerned the management of additional unforeseen scope. Whereas during scope development the scope items were evaluated on an individual basis, scope challenges were to review the master scope list as a whole in order to optimize the TAR scope and prevent any overlap. Furthermore a scope challenge was to check if the TAR scope was set-up in such a way that the risks to plant reliability, safety, etc. were aligned with the objectives of the business unit and balanced with the risks to the shutdown in terms of safety, cost, complexity, etc. The TAR manager initiated the scope challenge and invited people (**selection**) from TAR management as well as from the capital projects. In order to get an outside view on the scope he also invited people who did not participate directly in the TAR project such as experts from the firm’s TAR community, operations, other firm experts (inspection, process, technology or engineering) and independent consultants. “It is an advantage to involve people from outside the turnaround, because they can offer a cold eye review and spout their thoughts during the challenge meeting.”(I5)*

After scope challenge and scope freeze all work was sequenced and linked in the TAR tool (**centralization**) in accordance with the job execution logic. TAR-relevant portions of the construction execution plans for IMR2015, HI- and DCS-projects were brought together in the planning and scheduling tool (**pre-action reviews**) to link and schedule jobs so that serial and parallel work paths came clear. Integrated planning enabled a better coordination between the separate jobs and to reschedule some of them to minimize the shutdown duration and avoid conflicts (e.g. cranes becoming blocked in). Where the planning tool highlighted incompatibilities or overruns of time and/or budget, further **exploitation** of earlier build up knowledge and capabilities or the **exploration** of new knowledge and capabilities were timely initiated. “IMR2015, HI and DCS work were united into one integrated planning that allowed a safe, coordinated and timely work execution. The TMS tool needed to enable the conditional permission release system during the execution and therefor needed correct serial or parallel scheduling of interrelating tasks upfront. Then a permission to execute certain tasks would only be released after all the preliminary work permissions were completed. It was much more intensive than during other turnaround projects considering the extensive interrelations. We needed to disentangle all potential interactions and to find adequate solutions to schedule in advance all shutdown tasks in the TAR tool. The critical path then appeared automatically.”(I11)

The ongoing **strategic planning** process included to keep up-to-date a costing database / tool containing the historical costs of turnarounds as well as capital projects in order to facilitate cost estimation (**cost control**). Also effective cost estimation methods, so processes to estimate (turnaround) costs, are kept up-to-date. “There are different types of tasks and working points. Each gets a cost prediction based on historical data. Throughout the years, based on data from different

turnarounds at this or even other installations, standard costs can be determined.”(I3) After scope freeze, at the end of the basic planning phase, the frozen TAR scope was sufficiently detailed to provide the basis for development of a more precise TAR budget during the detail planning with an accuracy of 15-30%. This budget included estimated costs for the planning, execution and post shutdown phases and provided the required information to cover all different cost perspectives (e.g. personnel, service and material costs). It also included the contingency budget in order to account for costs associated with anticipated additional scope later on caused for instance by unforeseeable additional repairs, discovery work and estimation inaccuracy.

*Normally 3 to 4 weeks on average suffice for a shutdown of PlantPROD. Regular IMR2015-work required a shutdown of 2,5-3 weeks. Adding the replacement of the DCS was estimated to extend the shutdown to 4 weeks. The additional HI-project was expected to require a 5-weeks shutdown. This meant the capital projects caused a shutdown extension of 1-1,5 weeks, which was still within profitability limits (**cost control, boundary systems and diagnostic measurement**). When all three projects were elaborated and integrated (**pre-action reviews**), a shutdown of 7 weeks was expected due to the exceptional large, complex and interrelated capital projects. The maximum allowable shutdown to fulfill profitability requirements, however, was 5 weeks. It took considerable efforts and additional scope challenge meetings to optimize the planning further. “Idleness made the HI-project team planned much work during the shutdown. When all work was integrated into the TAR tool (**pre-action review**), one realized it was impossible to execute the HI-project within an acceptable duration without considerable risks (**boundary systems**). Only when one realized the duration would exceed its maximum and the project would be cancelled, a scope challenge with involvement of higher management (**interactive measurement**) caused a considerable reduction in duration.”(I5) Nevertheless, the reduced shutdown of 6 weeks was still too long. If the shutdown period could not be reduced, the HI-project forming a large part of the critical path would have been cancelled because the capital project was not profitable anymore. More deceptive thoughts needed to be considered. Work that had always been done serially due to operational and safety restrictions, was for instance now rethought considerably to enable parallel work streams. All involved parties were asked (**mechanistic communication**) to do additional exploration, to rethink processes to minimize the shutdown period, to consider some alternative processes that were avoided during earlier turnarounds because of the additional risks, to work out appropriate risk management procedures to cover potential additional risks... After doing their homework, all stakeholders were brought back together half a year before the planned shutdown for a meeting (**organic communication**) where top management interacted (**interactive measurement**) with them about time and cost budgets (**pre-action reviews** and **cost control**) considering the newly explored knowledge and capabilities. “We involved people who mastered expertise and reinforced ownership. The respective schedules were put together and discussed in diverse meetings. Problems were challenged and there was a positive search for solutions.”(I10) With additional **exploitation** but mainly additional **exploration**, the eventual planned shutdown was reduced towards 5 weeks, mainly by reducing the critical path of the HI-project from 35 to 30 days. The HIP-manager confirmed “The duration could be reduced by involving anyone that needed to do something on the critical path (**integrative liaison device**). Vague estimates with margins were challenged (**interactive measurement**), serial work was parallelized and the duration was reduced.”(I7) The TAR controller indicated that a mutual trust was very important: “We could not request the results in advance (**low tightness**). The turnaround needed to stay in control and safe (**boundary systems**), that was the first priority. We did ask facts and figures, and explanations (**interactive/diagnostic measurement**). But we relied on the sense of responsibility, commitment (**social control**) and a clear formulation of expectations and feasibility (**belief systems / socialization**). At that point people were willing to show margins. Then different parties agreed to have overlapping*

margins or collaborate in a way they could even obviate margins and the shutdown duration could be reduced.”(I8)

By the end of the planning phase a fully integrated and detailed TAR project execution plan, a communication plan, a documentation plan and a meeting plan were ready. Furthermore the organizational structure of the TAR project as well as the roles and responsibilities of individuals in the organization were clear and all preparatory work was done.

Furthermore there was a list of roles and responsibilities in the manual which were filled in during the planning process.

“We drew up an organigram at the beginning of the turnaround that was completed during the planning to define responsibilities and formal contacts.”(I12)

In sum two capital projects with considerable exploration besides the common exploitation, needed to be integrated with each other and the IMR work which again required considerable exploration besides the common exploitation with regard to planning optimization and integration. We thus followed a turnaround project with exceptional exploration and exploitation in both the planning of the individual projects as well as in the integration into a very tight shutdown window.

We can summarize the observed ambidexterity in one quote : *“You need to be innovative but innovation needs to be result driven”(I5)* This hybrid package was successful because controls stimulated exploitation and exploration simultaneously. And as long as innovation is result driven, there is no tension between exploration and exploitation!

Our interview data revealed that during the planning phase the following controls were essential: a standardized, detailed and tightly monitored planning and pre-action review process leading to a detailed project plan within pre-specified safety, quality, time and cost boundaries. Other predominantly used controls were interactive strategic planning, decentralized planning preparation by highly autonomous specialized teams, centralized but interactive planning integration, and a strongly shared company culture amended by a TAR performance mindset.

2. Execution phase

The desired execution was clearly summarized in the following quote:

“It’s like a formula 1 pit stop. Today 24 people are involved in a formula 1 pit stop and each of them needs to do something specific with the car. The pit stop lasts only 3 seconds”. (I10)

The IMR2015-work passed well in line with the prepared planning. No safety incidents, quality issues and time or cost overruns were noticed, despite many work was not done as usual and considerable planning efforts were necessary to work around expected issues and other risks. Despite the shutdown window for the critical path of the HI was reduced during the planning from 35 to 30 days and this required considerable changes in the planning, the actual execution of the HI-project passed flawless. The welding for the HI-project went even faster than planned and afterwards inspections indicated less rework than normally expected. *“The execution of mechanical work for the Heat Integration Project went more prosperous than expected and there was less rework.” (I10)* Furthermore the extensive planning process with regard to the DCS paid off. Testing of the new wires and operating system indicated that there were almost no mistakes. *“The Distributed Control System required a complete turnover of hardware as well as software that control the installation. The new DCS needed to be tested considering the high impact on operational efficiency, safety etc.. Based on historical*

experiences, some margins for rework were scheduled. Again the work passed by very fluently with less incidents and rework than usual.” (I10) There was not only the complexity of the DCS project, but also quite some inference with the heat integration and IMR2015 projects that also had to be implemented during the same shutdown. All measures could only be tested once construction was finalized. Testing of the DCS like this was always on the critical path of the shutdown. The plant could be restarted immediately at first try. There were no safety issues.

So overall the turnaround was a success story : the planning allowed an efficient and effective execution and the TAR2015 was completed earlier than planned. *“Production could be restarted 3 days earlier than planned.” (I10)* The faster project execution could not be anticipated during the planning considering it was not due to budget slack but to positive deviations from average time necessary to do some jobs. The duration of these tasks was estimated based on historical averages, sometimes a bit adapted to fit specific conditions. Logistics were thus not prepared to deliver all necessary semi-finished products, resources etc. and no additional profits were made. All 12 interviewees agreed later consistently that this faster project execution could not be predicted. *“This is similar to a car ride. You know that on average you need 20 minutes to drive through the inner city. One day you are lucky to have all traffic lights on green and your ride takes only 15 minutes. But if you will leave the next time only 15 minutes in advance, than either you will be late or you will need to take unacceptable shortcuts to be in time. If I now would need to plan the whole turnaround again, I would again take exactly the same expected times as the averages used for this turnaround.” (I10)*

We noticed how a changed emphasis on management controls contributed to the successful turnaround execution. When the execution started, almost everything was planned (**pre-action reviews**) and the focus shifted mainly to **exploitation** instead of the exploitation and exploration during the earlier planning. All people faced a **low autonomy** and **strict boundary systems** (e.g. safety, quality, duration and cost restrictions). *“It’s defined in the planning what needs to occur, and there is no degree of freedom anymore.”(I5)* The turnaround asked so much coordination that being ready in the preconceived time with each specific task was essential to not disrupt the coordination of subsequent jobs that would cause immediately far more delays. Care was taken that the overview of work going on was not lost and coordination was adequate (**diagnostic control**). The supervising work (**hierarchy**) was hereby mainly allocated to own staff. Integration of decentralized efforts during the planning was indicated as essential for a safe and efficient work execution (**exploitation**) during the shutdown. The integrated planning allowed to set up a highly integrated shutdown organization (**integrative liaison device**). The TAR tool delivered the work permits for a certain job only when all required preliminary jobs were fulfilled and their completion was marked in the system (**pre-action reviews**). *“The TAR tool is the system that guides the work permissions during the execution. One only gets a work permission for a specific task, when all predecessors, all preliminary tasks, are signed off.” (I8)*

Most mechanical work was executed by contractor firms who delivered workers as well as supervisors. There was a careful **selection** of contractors (during the planning) based on previous experiences of qualitative as well as collaborative aspects. They were, however, mainly selected because their abilities to comply with **exploitative** needs. These contractors got integrated work packages which they needed to execute exactly as planned (**exploitation**). Contractors got **performance pay** to foster **exploitation**: *“Contractors mostly get a bonus-malus system with regard to safety, work quality, house-keeping... If flanges would had leaked afterwards, they would have lost money. A bonus-malus system guaranteed contractors do their best.”(I6)* The performance pay for contractors is **objective** and **short term** focused. *“It’s quite severe (tightness). There is a strict scoring system and during the turnaround there is constant supervision. Each remark resulted in some blame assignment (diagnostic measurement). The contracting firms do their best to avoid remarks, especially with regard to safety and quality*

considering these measures had the highest impact. I do think it is a very good system.” (I8) **Performance pay** was considered effective to align ChemBE and the contractors. “The difference between ChemBE’s interest and the subcontractor its interest is that our installation is not cost-driven. Our efficiency requires a timely and qualitative execution of the shutdown. The efficiency for a contractor is mainly cost-driven. If we give that contractor a bonus to deliver timely and qualitative work (in a safe way), he will probably act accordingly what is far more important for us than the cost of the bonus.”(I5)

Besides performance pay, quite some non-financial incentives (**socio-ideological controls**) were noticed to **socialize** contractors’ employees with respect to safety, quality, duration etc. (exploitation). This was considered essential, because a bonus for the contractor firm did not flow back to their blue collar workers but often only to the owners and a limited number of managers.

“A safety café for all contractors was organized before initialization of the turnaround (**belief systems**). The diverse contractors got the work packages in advance and one of their headmen needed to present their planning for their part of the work some time in advance at a meeting with headmen of all other subcontractors. Despite the setting is quite informal, during a reception in a pub, no firm wants to make a bad impression so they ask a foreman to accurately prepare the planning before the presentation (**pre-action reviews**) to keep up the reputation of the firm.”(I8) Contractors hereby got **autonomy** by giving a large enough work buffer/backlog for all work that could be done without further safety coordination which enabled them to organize for maximal work efficiency (**exploitation**).

The days before the actual execution of the turnaround started all foremen/headmen were again brought together several times to present the whole planning and create awareness of their own as well as other’s responsibilities during the turnaround (**pre-action reviews and belief systems**). All jobs on the critical path (bottlenecks) were highlighted. This should make that all contractors could project themselves into the turnaround, felt committed to the work of others and were willing to contribute to overall success (**socialization**).

Also the contractor supervisors and mechanical staff arrived at the site in advance in order to get accustomed to the plant and the work for which they would be responsible (**socialization**). By the end of pre-shutdown, contractor workforces and support services obtained the necessary training and instruction (**belief systems** and **pre-action reviews**). A recently introduced innovation for training was the ability for e-learnings. In recent past all employees of subcontractors needed to do an extensive formal training before the start of the execution about important aspects such as safety, quality.... Employees of subcontractors who did this training earlier, however, did not need to do the whole training again but could brush up their knowledge with a shorter e-learning. **Socialization** was repeated during the actual execution. One offered three times a free lunch to all workers including the staff of the contractors to show appreciation for their work attitude and compliant behavior. It was a way to reward blue collar workers and retain commitment and goodwill. “There is always an advantage for your own when you grant other people a little joy to show your acknowledgement. Like this you get goodwill of people. It is very logic, when you show your appreciation to people, that is enjoyed by them.”

The integrated TAR management team was during the execution in the lead to stimulate an efficient planning execution (**centralization**). The mechanical workforce faced a very **limited autonomy** and **very stringent boundary systems** during the execution. Teams of mechanics were stimulated to execute all tasks exactly as prescribed during the planning. “The realization of the shutdown work needed to occur exactly as we planned before. This time we did not need any adaptations.”(I11) The integrated planning (**pre-action reviews**) assured that the contractors only received permits for all work that should not wait for unfinished predecessors and this way it assured compliance with safety, quality,

time and cost restrictions (**boundary systems**). The information flow towards the teams of mechanics was mainly top-down (**mechanistic communication**). The focus was during the execution more on compliance with the planning (**diagnostic control**) and the balance tended more towards a **hierarchical structure** and **mechanistic communication** patterns. *“As TAR manager I impose discipline during the execution and I use my hierarchical position.”*(I10) The much **taller hierarchy** for the mechanical work force was used because TAR management could not follow-up everything interactively, so a strict hierarchy allowed the necessary **diagnostic control** which was helpful to assure an efficient control of planning compliance.

All tasks were monitored diagnostically with the help of the TAR tool and supervision (**diagnostic measurement** and **centralization**). *“The integrated overview of the TAR planning allows that someone of the TAR department can monitor the whole and that there is a kind of supervision by that system.”* (I4) Any deviation from the preset planning was observed immediately and appropriate actions could be taken (**diagnostic measurement**). *“The TAR tool is the instrument that allows to detect deviations and adjust”*(I8) *“The TAR tool indicated potential deviations timely, e.g. by signaling if any non-critical job should be started immediately to prevent it would be postponed and interrupt the critical path.”*(I11) Workers only got the minimal needed resources which made they needed to make efficient use of resources (**exploitation**). *“Cost control during the execution was mainly recording the use of materials/cost drivers etc.”* (I8) The shutdown cost controlling/reporting process was aimed at signaling if costs did not develop in accordance with the expenditure plan and initiating corrective actions (e.g. adjust scope or budget) (**diagnostic measurement**). The TAR project controller analyzed the cost performance indicators and compared them with the budget and schedule, checked for anomalies as for instance unexpectedly high costs for certain activities, and summarized his conclusions to provide a cost report, part of the daily reports (**mechanistic communication**).

ChemBE’s own personnel had a constant exposure to **belief systems** as well as **socialization** processes that convinced them of the importance of safety, quality, timing and cost (especially during the turnaround). Often these people were also involved in the planning phase which made this **socialization** even stronger and enabled **social control**. *“The awareness about the critical path had already been created in advance. We always need to reduce the shutdown as much as possible and we worked out the detailed planning in advance. If you deviate from the critical path, you know you will get troubles. A couple of tasks need to be done. Each task separately does not take so long, but some jobs need to occur serially.”*(I8) Own staff who were culturally aligned, were therefor used as supervisors (**selection**). *“The own staff of the PlantPROD as well as other installations and departments of ChemBE were allocated to essential jobs or served as reliable supervisors because management trusted them more.”*(I4)

Problems were not solved by the teams of mechanics or supervisors themselves. TAR management had daily progress meetings, where progress, safety and quality issues were discussed (**diagnostic measurement**). *“There are daily turnaround assemblies (**communication**) where all members of the TAR management team and headman of the contractors are brought together (**integrative liaison devices**) and progress and issues are discussed (**diagnostic measurement**). Important topics are safety, housekeeping... which creates a certain mindset (**socialization**).”*I8

The TAR tool allowed to assess accurately the impact of discovery scope and remodel the necessary actions (**pre-action reviews**). There was a standardized shutdown scope management process (**standardization**) that provided an effective workflow for documenting, controlling and approving scope changes after the start of the shutdown (**pre-action reviews**). Again management needed to use a **combination of mechanistic and organic patterns** in case additional **exploitation** and **exploration** were necessary to handle problems. Issues were discussed with direct involvement of TAR

management (**centralization** and **restricted autonomy**). TAR management tightly followed-up themselves any progress (**tight control**) and stimulated an appropriate combination of exploration and exploitation (**interactive measurement**). The TAR management team was still organized as an **integrative liaison device** and also prepared potential adaptations to the integrated TAR planning tool (**integrative liaison device**).

Cost control was mainly focused at *exploitation*, but when issues aroused, cost control was an important help to elaborate optimal solutions (**exploration** and **exploitation**). One faced high time pressure in case of issues because shutdown delays would cause enormous costs. This made that management was willing to make additional costs to avoid any delay. *"If it is really critical, cost doesn't matter because additional costs never balance out the potential loss of getting a delay. But first safety and quality, then duration and then cost."*(I6) It illustrated how cost management during the shutdown was mainly determined by avoiding time overruns (**boundary systems**).

The implementation of the solution in case of issues, is done by a special "*crash team*". The crash team was a team of experienced company personnel (**integrative liaison devices**) that was involved in the solution of problems. While other mechanics could focus exclusively on the adequate execution of the prepared planning, the crash team needed to overcome issues by finding adequate solutions (**exploration** and **exploitation**) in consultation with the TAR management team. So only the TAR management team, other supervisors involved in the TAR meetings and the crash team needed to combine exploitation and exploration in case of problems, while the mechanical work force could stay focused on exploitation. *"In case of unexpected issues, innovation or exploration is often very important to remain efficient. The best and most experienced people are selected to do unknown work or work that will probably require exploration. Then you need to reflect a lot and be innovative, which requires sufficient experience."*(I5) Again this illustrates that **selection** contributed to ambidexterity.

We illustrate this control approach with one *major problem* that occurred during the TAR2015. The main axle of the carrier gas compressor was, totally unexpected, disapproved by routine controls and without this compressor the plant could not work. The production of a new axle required a fabrication time of at least some weeks. A shutdown of 5 weeks, extended with some weeks would be an operational and financial disaster. And normally (**standardization**) there were some emergency plans for the risk of non-reliability of essential parts that could be broken (e.g. by agreements with suppliers or collaborations with other plants), but this disapproval was not predicted by any estimate at all. Immediately considerable **exploitation** and **exploration** were undertaken. Different top managers including the manager of the product installation (I1), the TAR manager (I10) and the head of the product group (I5) interactively followed up (**interactive measurement**) the advancements and helped to find solutions themselves (**centralization**). They used their network of specialists at other business units, in other countries or even outside ChemCo. With an amazing dedication, the TAR management team succeeded to tackle the problems. Different scenarios were elaborated. Finally they reduced the fabrication time enormously by negotiation with some suppliers and were prepared to reschedule different jobs if necessary so that the shutdown would only be extended by six days. But simultaneously they involved other experts to test the axle. The test process, however, required unique machinery to test magnetic effects and no other Belgian company could do it. Via their network they found out that a Dutch aerospace engineering company executed similar tests for a totally different purpose. This Dutch company concluded that the axle was safe and the applied test process was inappropriate because too high magnetic field strength caused spurious effects. So a combination of exploitation and exploration stimulated by management itself led to an adequate solution. Meanwhile the rest of the turnaround organization was only aware that TAR management was solving

some problems and could remain focused on the efficient and compliant execution of the planned work.

We can conclude that the integration of the two capital projects (HI and DCS into M&R) occurred very precisely and accurately during the planning and this enabled a smooth execution. Accurate collection of known scope, reliable estimates of expected unknown (discovery) scope, extensive preparation of all shutdown work, good linking during the planning of all tasks, conditional permit release during the execution by means of the integrated TAR tool and TAR organization, and a tight follow-up of any deviations as well as discovery scope, enabled to maintain an overview and manage safe working conditions.

Key control systems used in the execution phase were: a strongly integrated organization with centralized locus of authority, limited autonomy, pre-action reviews prior to activity, diagnostic performance measurement of mechanical workforce activities with focus on achieving pre-set safety, quality, time and cost targets, a high performance execution mindset, use of performance based compensation for contractors and a standardized planning review process with interactive planning reviews in case of performance deviations and emerging issues at the level of the TAR management team.

3. Post-shutdown

After the shutdown, when the installation was already restarted, the remaining work was finalized as planned and all resources were demobilized and reintegrated into their originating organizations. A closure drink was kept to celebrate the successful execution and to thank everyone for their efforts (**socialization**). Interviewees indicated that involved people enjoyed the successful project execution: *“Installation personnel who were responsible to prepare some tasks and did their best to execute them, were pleased by the good results.”(I8)*

Learning during the *lessons learned processes* enabled the reuse of acquired knowledge and capabilities (**standardization**) during future turnarounds. Everyone was stimulated to share during surveys as well as different meetings what they had learned during the past turnaround and their thoughts of any directions for future improvements (**organic communication**). Opportunities for **exploitation** and **exploration** did not need to be immediately feasible, considering there were **no strict boundary systems** such as faced during planning and execution. *“Innovation is not something you can explore at demand. Most innovation originates in sharing ideas, problems or experiences. I think we all have a reasonable freedom to explore.”(I12)* Statements stimulating continuous improvement (**belief systems**) and the TAR management team fostered everyone (**socialization**) to come up with ideas during the surveys. Everyone got **considerable autonomy** to think about improvements without direct involvement of management (**decentralization**).

Besides the TAR manager himself (**interactive control**) selected some people involved in planning and/or execution (**selection**) to participate in the lessons learned meetings where all lessons learned were discussed (**organic communication**) with diverse people to take into account all points of view (**integrative liaison device**). It was a **more centralized, interactive process**, although **less hierarchical** than during the execution. The most important lessons learned (**exploitation** and **exploration**) were collected, summarized and validated.

Afterwards the TAR manager summed up all lessons learned in the final TAR report (**mechanistic communication**) and also put them into a worldwide accessible lessons learned database to ensure

their availability for later TAR projects (**standardization** and **pre-action reviews**). Some ideas for strategic initiatives or other ideas for improvements with regard to the installation, turnaround process or new capital projects even initiated **strategic planning** for next turnarounds.

During this turnaround project new learning (*exploration*), especially with regard to the two capital projects and the integration of HI, DCS and the normal IMR work, as well as the reuse of past knowledge and capabilities (*exploitation*) were noticed during the planning and execution phases,. Now these knowledge and capabilities, acquired during this turnaround, were captured to reuse during later turnarounds. Furthermore one also considered potential capital investment improvements and even turnaround process improvements (e.g. with regard to the integration of capital project work and IMR work). This is in line with both Fiol and Lyles (1985) and Kloot (1997) who distinguished single and double loop learning. The kind of learning noticed during the post-shutdown was both single and double loop learning.

Quite some single loop learning efforts were done. First of all planning relevant for future turnarounds was afterwards stored in the library of the planning tool for future reuse (**standardization**). *"We use the TAR tool. Previous work preparations are stored within its library, which makes we only need to control and update them. We become more and more efficient. Eventually, we want to compose a library where we can retrieve 70-75% of all task descriptions."*(I9) Differences between the predicted duration and actual duration of tasks (**diagnostic control**) were discussed during the review meetings (**organic communication**). Like this flaws in the used **pre-action reviews** were gathered and this useful experience allowed to come up with improvements for future turnarounds. *"Sometimes maintenance issues arise unexpectedly during a turnaround and other times the experience learns we do too often inspections or maintenance. In both case I adjust the inspection and turnaround requirements in the preventive maintenance plans in SAP."*(I12)

As earlier mentioned, all new cost data were stored in the costing database / tool containing the historical costs of turnarounds as well as capital projects in order to facilitate future cost estimations. Also effective cost estimation methods for the turnaround work as well as the capital projects, so processes to estimate (turnaround) costs, were kept up-to-date (**cost control**). *"Each turnaround we analyze the actual costs post-shutdown and calculate an average cost per type of work. Turnaround per turnaround we calculate new averages, replenish our cost data and approach the true average cost."*(I8) Furthermore the final TAR report contained detailed final cost analysis and allowed performance evaluation and benchmarking (**cost control**). Deviations between predicted and actual costs were discussed (**diagnostic control**). *"Each turnaround the eventual cost calculation can be verified with the predicted (standard) cost. Like this historical costs and the cost estimation process can be optimized throughout the years for turnaround work."*(I8)

An important statement was that the turnaround process would need to change considerably because the catalyst lifetime was increasing and the whole turnaround process of PlantPROD was based on it. *"Tighter boundary systems can cause innovation. The catalyst lifetime is increasing from 18-24 months toward three years. This extension of the duration between two shutdowns, forces us to reconsider the turnaround process of the installation."*I12 Double loop learning was thus unavoidable.

Also the TAR2015 delivered plenty of examples of and ideas for double loop learning (**strategic planning**). The standardized TAR procedure was extended in subsequent versions of the TAR manual by retaining and re-using lessons learned (*exploitation* and *exploration*) (**standardization**) to ensure continuous improvement in TAR project performance in future TAR projects.

"With regard to maintenance, a new procedure was being elaborated at the time of the turnaround project to let the department responsible for large machinery be more turnaround-oriented. In fact we

encouraged them from above to explore. The brain teaser took multiple years (**belief systems**). Awareness of the turnaround restrictions was created, success criteria were indicated (**measure diversity**) and potential improvements were explored." Considering the success of the brain exercise, TAR management is considering to ask project engineering to do a similar one. "We should create enough awareness for turnaround requirements within project engineering (**socialization**)."(15)

The HI-projectmanager (17) mentioned that engineering also had some double loop learning processes : "Many processes in the engineering and mechanical work departments are focused on standardization of processes to enable an optimal work execution." The HI-projectmanager explained how the combination of a standardized TAR process and tight follow-up by TAR management was essential to implement HI effectively and efficiently. "An advantage of the TAR department and its standardized TAR process is their structured approach. A normal project that does not need to be integrated into a shutdown does not have strict time constraints. This project needed to be integrated into a shutdown period and therefore management focused on its progress and we needed to communicate transparently and immediately. The TAR management team organized meetings on a regular basis to compare the intended planning progress with the actual progress. These follow-up activities were more strict. In case of problems the management attention enforced priority. Because your project team is part of the TAR organization, and everyone is aware of the importance of turnarounds, you can work with a higher focus and intensity to obtain the project objectives." (17)-He considered it a valuable experience to "be forced into a turnaround organization with time restrictions and strict follow-up by TAR management." A change in the turnaround planning process (**standardization**), would be the earlier integration of project work (**integrative liaison devices**). This proved to be essential during this turnaround and management considered to work out additional policies and procedures to assure a timely integration. "I think we lack enough integration from IMR and capital project work from the beginning on. Initially, each is considered too much apart. We need to stimulate the integration earlier."15 Furthermore the cold eye review with people not involved in the turnaround showed valuable. They considered to always prescribe such a cold eye review (**standardization**). "It is an advantage to involve people from outside the turnaround, because they can offer a cold eye review and spout their thoughts during the challenge meeting."(15)

Some lessons learned proposed a better collaboration with contractors in the turnaround process (**standardization**). "I think we should develop an efficient partnership model to encourage improvement contributions by (sub)contractors."(15) Another important observation was the need for more involvement of related production installations or departments to align turnaround processes more with other stakeholders. "I realized during this turnaround that the whole supply chain as well as marketing and sales need to be involved more into the planning process. It is a domain the turnaround department needs to strive for improvements by challenging the operations department (**interactive measurement**)."(110) Also a safety café proved to be very effective to force contractors to prepare their work precisely and timely. This safety café would become part of the standardized turnaround process.

Post-shutdown the TAR management team encouraged the TAR planners to evaluate planning performance, identify which project activities had been effectively executed as planned and to store successful planning elements in the library of the planning tool, such that these could be reused (as a standard) in future turnaround projects. Planning activities that had not been successful were discussed with the objective to identify lessons learned to improve future (strategic and operational) planning performance and the future planning process.

Key control systems used in this phase were socio-ideological controls, interactive control of planning performance and process, moderate hierarchy, organic communication patterns,

decentralized locus of authority, absence of boundary systems, moderate autonomy and integrative liaison devices.

5.4 Where there tensions within the control package?

The fourth main question of the semi-structured interviews was *“Is the used package appropriate?”*. Hereby we questioned if controls were independent, opposing or complementary. Follow-up questions were for instance *“Do you think of some specific controls that reinforce or hinder each other or do you think all management controls are independent?”*

All twelve interviewees considered the package as optimal. *“We do it right, the way we do it now.” (I5)* One noticed no opposing tensions, but rather complementary effects between management controls. *“I think that all management controls together give the largest advantage. You do not need to do a bit less of the one because of the other. They reinforce each other, they do not oppose each other.” (I8)* *“I think [the management controls] are complementary.” (I1)*

VI. Case study learnings

The case study research learned that (1) a hybrid package of controls effectively fostered ambidexterity. It also clarified that (2) controls individually and jointly contributed to exploitation and exploration and that (3) the emphasis in the use of controls in the project context was not static but changed dynamically during the process cycle of the project. (4) No evidence of any tensions within the control package and between the different control modes was noticed, which substantiates the view of exploration and exploitation as orthogonal concepts. Furthermore the case demonstrated that (5) the hybrid package stimulated both single and double loop learning and that (6) these learning processes assured timely adaptation of the control package to changes in the ambidexterity requirements in the complex dynamic environment.

Hybrid control package (1)

There is an extant use of strategic planning, measurement, policies and procedures and socio-ideological controls. Structural characteristics are a highly integrated project organization with decreasing decentralization during the planning and centralization during execution, a clear hierarchy and mechanistic communication structures combined with organic communication patterns. Performance pay is used for contractors, and partly for ChemBE personnel. This limited emphasis on performance pay, is the only difference with the hybrid package of Bedford and Malmi (2015). With regard to individual incentives of ChemBE personnel, performance pay is not considered as a main driver for individual behavior. Socio-ideological controls are mentioned to lead to motivation and organizational commitment with regard to both exploration and exploitation.

Ambidexterity is thus fostered by a package very similar to the hybrid package identified by Bedford and Malmi (2015) : a high use of policies and procedures, measurement and socio-ideological controls in an organizational structure that combines mechanistic and organic patterns.

We first compare the found package with the hybrid package part of the taxonomy derived from practice by Bedford and Malmi (2015) (see Table 11).

Table 11 Package of controls in TAR project

Hybrid control package suggested by Bedford and Malmi (2015)	Observed control package in TAR2015 project	Which phase? P / E / PS
<ul style="list-style-type: none"> • great emphasis on strategic planning • high level of participation in strategic planning • tightly emphasized accountabilities to a wide array of metrics • strong performance-based incentives 	<ul style="list-style-type: none"> • great emphasis on strategic planning • high level of participation in strategic planning • tightly emphasized accountabilities to a wide array of metrics – tight monitoring and steering • strong performance-based incentives for contractors moderate performance-based incentives for staff, innovation bonus for non-staff 	<ul style="list-style-type: none"> • P • P • P/E/PS • <u>Contractors</u> E <u>Staff</u> P/E/PS
<ul style="list-style-type: none"> • delegated decision authority • boundary systems • standardization and pre-action reviews • discretion in conduction of work activities • moderately organic patterns of interaction • use of lateral integrative devices • high reliance on socio-ideological controls 	<ul style="list-style-type: none"> • delegated decision authority • boundary systems • standardized turnaround process • pre-action reviews • discretion in conduction of work activities • moderately organic patterns of interaction • use of lateral integrative devices • high reliance on socio-ideological controls 	<ul style="list-style-type: none"> • P • P/E • P/E/PS • P/E • P/PS • P/E/PS • P/E/PS • P/E/PS

Bedford and Malmi (2015) expected the hybrid control package could enable ambidexterity. The package that enables ambidexterity in the case study is indeed similar with respect to strategic planning, measurement, structure, policies and procedures and socio-ideological mechanisms. Tightly emphasized accountabilities to a wide array of metrics, a great emphasis on strategic planning, boundary systems, standardization and pre-action reviews, are balanced with a high level of participation in strategic planning, delegated decision authority and autonomy in conduction of work activities during the planning, moderately organic communication patterns, constant use of lateral integrative devices and high reliance on socio-ideological controls. Furthermore contractors get strong performance-based incentives. ChemBE staff members do have performance pay for objective targets with both long and short-term horizons. Targets are perceived just strict enough to require collaboration but not too strict that still explorative efforts can be done in the interest of the firm. Nevertheless, all staff members indicate they are mainly driven by the strongly shared culture. Non-staff members can only get a bonus for innovative ideas. Just as staff members, they indicate that the mutually shared values are the main driver for their ambidextrous behavior.

How do management controls foster exploration and/or exploitation? (2)

The case study reveals a highly standardized turnaround process that effectively succeeds to create project ambidexterity by means of a hybrid management control package. The package approach uncovers the respective roles of different management controls. Strategic planning starts years before and fosters exploration and exploitation when it is sufficiently detailed, organized in a participative way leading to internal strategic alignment and allows timely preparation of innovations. A tight monitoring and steering system is in place and this measurement implies a high extent of results control. Tight diagnostic and interactive operational project performance measurement, enables exploitation as well as exploration when standards are carefully planned in an interactive and participative way, the compliance during the execution is strictly monitored and the experiences are used afterwards to identify needs for exploration during the post-shutdown phase. Detailed cost measurement enables exploitation but also helps to discern domains where exploration should be appropriate. A combination of diverse organic and mechanistic structural aspects, resulting in moderately organic communication patterns, also seems essential for ambidexterity. The hierarchy is clear during the whole turnaround, and the project organization is highly integrated with the help of two integrative liaison devices: the TAR tool and the integrated turnaround team. The locus of authority is decentralized during the planning and post-shutdown and more centralized during the execution. Communication contains mechanistic communication structures in which organic communication patterns are built in. The combination of structural controls stimulates exploration as well as exploitation. Policies and procedures also contribute to ambidexterity. The way the project is planned, managed and executed is strictly described in the TAR manual which implies standardization and exploitation of standardized processes. But the standardized processes also foster exploration and exploitation at certain points during the turnaround cycle such as during the planning, in case of issues or planning deviations during the execution and during the lessons-learned processes post-shutdown. The extent planning illustrates the importance of pre-action reviews. Autonomy enables and motivates subordinates to use their knowledge and experience to find an optimal balance in the planning between exploration and exploitation. Limitations and boundaries force everyone to work efficiently, but at the same time limitations force the project teams to be innovative if current knowledge and skills are inappropriate to stay within these limits. Performance pay fosters exploitative behavior of contractors and collaboration amongst staff members. Non- staff members only get a bonus for additional explorative efforts. Both exploration and exploitation are stimulated strongly by socio-ideological controls. Selection, socialization, belief systems and social control create a strongly shared culture that stimulates ambidexterity.

Dynamic emphasis on the use of controls during the process cycle (3)

The emphasis in the use of controls in the project context is not static but changes dynamically during the process cycle of the project. In the **planning phase** the accent is on the use of a standardized, detailed and tightly monitored planning and pre-action review process whereby subordinates get some autonomy to combine exploration and exploitation but eventually it leads to a detailed, reliable and integrated project plan. During the **execution phase** this plan is monitored diagnostically to enforce compliant behavior and thus exploitation of the preceding planning efforts. In the **post shutdown** phase interactive planning performance evaluation and stimulation by belief systems and leadership foster exploitation and exploration in order to exploit acquired knowledge and capabilities and explore new knowledge and capabilities such as planning parameters and process improvements.

To foster exploration and exploitation during the planning and post-shutdown, one allows some decentralization and considerable autonomy for employees while stimulating them by socio-ideological controls to be innovative and strive for safety, quality, time and cost objectives.

Nevertheless, there is still a high influence of other policies and procedures such as boundary systems, standardization and pre-action reviews together with a clear hierarchy, integrative liaison devices, mechanistic as well as organic communication and tight diagnostic and interactive measurement. During the execution all work has been prepared in advance. Everyone then only has minor autonomy and there is a highly centralized organization. Again there is a high influence of policies and procedures such as boundary systems, standardization and pre-action reviews together with a clear hierarchy, integrative liaison devices, mainly mechanistic communication with some organic communication patterns as well and very tight diagnostic and interactive measurement. This combination of management controls kept everyone focused on an efficient execution of the prepared planning. Integrative liaison devices (TAR tool, integrated TAR organization) and regular communication are, just as the socio-ideological controls, considered essential as integration mechanisms during the whole turnaround. They are also used to create the necessary shift in mindset between turnaround phases.

Another example of dynamics is how cost measures are used interactively during the planning and post-shutdown when they are used to question budgets or for learning purposes, but diagnostically during the execution to stimulate compliance. There is also a difference in the tightness with regard to policies and procedures which can be questioned within certain limits during the (early) planning and during post-shutdown learning processes. During the execution the tightness is much higher and no deviations from the prepared planning are tolerated.

Orthogonal ambidexterity view (4)

No remarks about inconsistent or opposing management controls were received despite explicit questioning of the appropriateness and fit of diverse management controls when striving for exploration and exploitation. Different employees mentioned it would not be appropriate to change single controls because this would harm the effectiveness of the package. For instance individual incentives for ChemBE employees mainly rely on socio-ideological controls which is preferred above performance pay by interviewees because a too high emphasis on performance pay would cause tensions between competing company and individual objectives and harm ambidexterity. All interviewees considered the observed hybrid management control package as optimal. Considering no tensions are found between management controls within the package nor between exploration and exploitation, the findings substantiate the orthogonal view of ambidexterity.

The role of single and double loop learning in fostering exploitation and exploration (5) (6)

The case study illustrates how a hybrid management control package can stimulate single and double loop learning. Measurement, policies and procedures and socio-ideological controls, embedded in both mechanistic as well as organic structures, foster apart and together exploration. Despite outcome measurability and task programmability are per se low in the turnaround context, accounting (measurement) and planning tools (policies and procedures) are used as information tools during the planning and facilitate control. The hybrid package demonstrates its ability to eventually enable both outcome measurability and task programmability in a turnaround context characterized by unpredictability, turbulence and complexity. A constant process with single and double loop learning has allowed continuous improvement and TAR management like this gets grip on a complex, dynamic and uncertain environment. Socio-ideological controls stimulate professionals to combine exploration and exploitation with regard to their specific task while senior managers by means of diagnostic and interactive measurement and pre-action reviews guard strict compliance with the TAR process. The reward policy, which is limited and focused on objective and long term targets as well, creates mutual accountability within teams. Performance pay of staff members is not based on short term targets and does not obstruct learning. Non-staff members even get innovation bonuses to stimulate learning. A

combination of socio-ideological controls, policies and procedures and measurement thus stimulates both innovation and efficiency.

The hybrid package stimulates single and double loop learning during the project and these learning processes assure timely adaptation of the control package to changes in the ambidexterity requirements in the complex dynamic environment. An example of single loop learning is the constant measuring and updating of time and cost data within the current tools. An example of double loop learning are the changes initiated in the turnaround management control processes, such as a better integration of capital projects within the turnaround process, pre-action reviews in accordance with suppliers and the sales department and more involvement of contractors during the operational planning process. Also the interviews indicate that single and double loop learning serve as a key underlying mechanism mediating the relationship between the observed control package and ambidexterity. During the post-shutdown phase the control package fosters exploitation and exploration especially by active stimulation of learning processes. Strong belief systems, organic communication patterns, a flat hierarchy and interactive involvement by management stimulates everyone to share lessons learned. This learning is used to update planning parameters (single loop learning, e.g. by means of updating of cost data), to adjust shifts of beliefs and actions (double-loop learning, e.g. by creation of the TAR mindset at the engineering department) and to encourage reflective action-making (double-loop learning, e.g. the integration process for capital projects will be optimized).

VII. Discussion

Our results contribute to the literature (1) by finding practical evidence that a hybrid package of management controls indeed can enable ambidexterity, (2) by explaining how a hybrid control package and the diverse individual controls have an impact on achieving ambidexterity, (3) by expanding our understanding of the dynamics in use of and emphasis on controls within the hybrid package, (4) by retrieving different control modes without tensions which is a contribution to management control research but also (5) substantiates to ambidexterity literature stating that exploration and exploitation can exist as orthogonal concepts, and (6) by expanding our understanding of single and double loop learning in a project context.

Hybrid control package (1)

Initially, studies in management accounting research questioned the ability of an organization to enable ambidexterity. It was considered as a trade-off decision whereby the combination of exploration and exploitation requires a trade-off decision in resource allocation and opposing management practices which leads to internal tensions and conflicting demands (Benner and Tushman 2003, Eriksson and Szentes 2014). March (1991) broke a lance for the combination of exploitation and exploration to achieve short term performance as well as long-term survival and success. Firms may not focus only on exploitation of existing knowledge and technologies for short-term profits, but also need to improve existing capabilities to deal with threats to firm survival (O'Reilly and Tushman 2013). A focus on either exploration or exploitation obstructs organizational longevity (O'Reilly and Tushman, 2013, Turner, Swart, Maylor, 2013). A mere focus on exploitation to maximize short-term benefit can lead to long-term failure if the organization cannot adapt to changes in its environment due to a lacking exploration. A mere focus on exploration will lead to a never-ending renewal without short term valorization so that short-term organizational survival can even be threatened. Turner, Swart, Maylor, (2013) refer to Levinthal and March (1993, P105) who conclude *"The basic problem confronting an organization is to engage in sufficient exploitation to ensure its current viability and, at the same time, to devote enough energy to exploration to ensure its future viability"*.

Subsequently Turner, Swart, Maylor, (2013) refer to He and Wong (2004, P481) who explain the barriers that impede such ambidexterity : *"exploration and exploitation require substantially different structures, processes, strategies, capabilities, and cultures to pursue and may have different impacts on firm adaptation and performance. In general, exploration is associated with organic structures, loosely coupled systems, path breaking, improvisation, autonomy and chaos, and emerging markets and technologies. Exploitation is associated with mechanistic structures, tightly coupled systems, path dependence, routinization, control and bureaucracy, and stable markets and technologies."* Such previous literature thus indicated that firms can only achieve both by a combination of multiple contradictory structures, processes and cultures (Tushman and O'Reilly III 1996).

This paper now clarifies how management controls can be used to foster ambidexterity. In terms of the package approach, Bedford and Malmi (2015) suggested in which circumstances a certain (probably internal consistent) package of controls would be most likely. Bedford and Malmi (2015) found opposite needs for management controls when it came to initialization of exploration and exploitation.

With regard to exploration one expects socio-ideological controls considering the lack of outcome measurability or task programmability (Ouchi 1977, Ouchi 1979, Eisenhardt 1985, Snell 1992), within organic structures considering the complex, dynamic and uncertain environments (Burns and Stalker

1961, Mintzberg 1979, Mintzberg 1989, Speklé 2001). Two packages contain a high level of socio-ideological controls : the devolved and hybrid control package. With regard to exploitation one expects measurement in case of high outcome measurability, low uncertainty and stable, predictable environments (Burns and Stalker 1961, Ouchi 1977, Ouchi 1979, Eisenhardt 1985, Snell 1992, Speklé 2001, Vosselman 2002) or policies and procedures in case of high task programmability, low uncertainty and stable, predictable environments (Ouchi 1977, Mintzberg 1979, Ouchi 1979, Eisenhardt 1985, Mintzberg 1989, Snell 1992, Speklé 2001, Vosselman 2002). In case either measurement or policies and procedures are used, these are expected in combination with mechanistic structures which are again expected in stable, predictable environments with a low uncertainty (Ouchi 1977, Mintzberg 1979, Ouchi 1979, Eisenhardt 1985, Mintzberg 1989, Snell 1992, Speklé 2001, Vosselman 2002). Three of the packages of Bedford and Malmi (2015) contain a high level of bureaucratic controls: the results, action and hybrid control package.

Contrary to these earlier findings, we observe measurement effective in environments not characterized by high outcome measurability, low uncertainty, stability and predictability. Furthermore we also find extent use of policies and procedures, which is associated in literature with high task programmability, low uncertainty and stable and predictable environments (Ouchi 1977, Mintzberg 1979, Ouchi 1979, Eisenhardt 1985, Mintzberg 1989, Snell 1992, Speklé 2001, Vosselman 2002), in a complex, dynamic and uncertain project context where the task programmability is not straightforward such as the planning and post-shutdown phases and when issues or planning deviations occur during the shutdown. Furthermore we observed the use of mechanistic structures to foster exploitation in this uncertain, complex and dynamic turnaround environment despite these normally fit with stable, predictable environments with a low uncertainty (Ouchi 1977, Mintzberg 1979, Ouchi 1979, Eisenhardt 1985, Mintzberg 1989, Snell 1992, Speklé 2001, Vosselman 2002). The case study findings thus nuance the findings of Burns and Stalker (1961) that a mechanistic organization containing formalized and mechanistic structures is optimal for stable environmental conditions whereas an organic organization with informal and lateral structures is appropriate in dynamic and uncertain settings. Both were successfully combined during the TAR2015 in a hybrid package that successfully strives for low cost, innovation as well as quality and flexibility.

In line with Bedford and Malmi (2015) the hybrid package is thus found in a context where low cost, innovation as well as quality and flexibility are essential. A remarkable finding is that ambidexterity is effectively managed by a hybrid package in an uncertain, complex and dynamic turnaround environment with a low outcome measurability and task programmability whereas Bedford and Malmi (2015) linked the hybrid package with high outcome measurability and task programmability in a rather predictable, simple and stable environment.

How do management controls foster exploration and/or exploitation? (2) ; The dynamic emphasis on the use of controls during the process cycle (3)

Bedford and Malmi (2015) asked for additional research that explains more in detail how the diverse packages function and in which contexts these are effective. Bedford and Malmi (2015) assumed based on theories of ambidexterity that the variety of management controls within the hybrid package could probably foster ambidexterity. Our qualitative research now confirms the ability of the hybrid package to manage project ambidexterity and allows to clarify how a hybrid package effectively manages ambidextrous requirements in an uncertain, complex and dynamic environment.

The observed hybrid control package contains a broad array of management control practices. The emphasis on the use of accounting controls evolves. Depending on the phase, and the respective focus

on exploration and exploitation, specific controls get more importance. When exploration is required, we observe as expected in literature a higher emphasis on socio-ideological controls (Ouchi 1977, Ouchi 1979, Eisenhardt 1985, Snell 1992) and organic structures to cope with the complex, dynamic and uncertain environments (Burns and Stalker 1961, Mintzberg 1979, Mintzberg 1989, Speklé 2001). When exploitation is required, we observe as expected in literature measurement practices (Burns and Stalker 1961, Ouchi 1977, Ouchi 1979, Eisenhardt 1985, Snell 1992, Speklé 2001, Vosselman 2002).

One clear example is the use of measurement controls during the turnaround project cycle. Overall during the planning we notice a more socializing style of accountability which facilitates exploration and exploitation. During the planning processes diagnostic control is used to monitor through deviations from preset standards and like this planning is kept on track. Exception-based monitoring demonstrates as indicated by Speklé (2001) effective to decentralize so that individuals have the autonomy to decide quite autonomous how flexibility, or in this case a combination of exploration and exploitation during the planning preparations, can be achieved. Simultaneously, extensive and regular interactive control is used during the planning by management to encourage debate, experimentation, opportunity search and address strategic uncertainties in line with Simons (1995). Interactive control is also used by management to regularly follow up subordinates planning progress. During the execution accounting serves more as the traditional source of control. Both diagnostic control and interactive control are used by management to enforce an efficient and effective execution of the prepared planning by monitoring activity through deviations from the planning and by regular interactive involvement. The diagnostic and interactive control by the TAR management team also contributed to exploration and exploitation in case of planning deviations or issues. Post-shutdown accounting measures are used again in an interactive and diagnostic way to stimulate both exploration and exploitation. During planning and post-shutdown we thus observe that accounting can be used to focus attention, share knowledge and encourage exploration as found by Bedford and Malmi (2015).

Policies and procedures were used to set limits to behavior or even to specify how tasks needed to be performed (Bedford and Malmi, 2015). These indeed specified how the TAR processes must occur or how work needed to be done. During the planning a standardized planning process was used which specified how planning activities needed to take place, but the emphasis was more on developing pre-action reviews and everyone got autonomy within certain reasonable boundaries. So within the standardized planning process considerable autonomy was built-in that allowed individuals to optimally combine exploitation and exploration. During the execution the high standardization, extent pre-action reviews and very tight boundaries allowed to just strictly follow up the activities prescribed in the work permits generated by the TAR planning tool. Tasks that had been planned in advance could now be monitored (Ouchi 1977, Eisenhardt 1985). Post-shutdown the lessons-learned process was again described by the TAR processes. More autonomy and looser boundaries allowed individuals to provide bottom-up input with regard to both exploitation and exploration. So also with regard to policies and procedures we observe that the focus on exploration and exploitation differs among stages and the use of different controls in the hybrid package changes accordingly. We thus agree with earlier research (Adler, Goldoftas et al. 1999, Ahrens and Chapman 2004, Bedford and Malmi 2015) that flexible bureaucratic structures can be designed to perform in highly dynamic environments. Just as Alvesson and Kärreman (2004) we also found a complementary relationship between bureaucratic controls and socio-ideological controls : one creates awareness among the project member about the necessity of the policies and procedures and cultural aspects stimulate an appropriate focus on exploration and/or exploitation during the different phases.

Papke-Shields, Beise et al. (2010) found that standardization in project management always concerns *time*, *scope* and *cost* which are typically more quantifiable whereas the standardization of for instance

communication, quality, risk and integration differed. We noticed how an ambidextrous project organization succeeds to standardize all seven aspects. Milosevic and Patanakul (2005) indicated that standardization probably has some maximum above which standardization not further fosters project effectiveness but constrains it because project employees are constrained when trying to utilize exploitation or strive for necessary exploration. Milosevic and Patanakul (2005) found that project success mainly depends on standardized project management processes, standardized project management tools and standardized project leadership but also a standardized project organization, standardized information management system, standardized project management metrics and a standardized project culture are helpful. In addition we retrieved the influence of the standardized turnaround project culture or turnaround mindset on success in the TAR2015 project. Just as Papke-Shields, Beise et al. (2010) we conclude that project-based organizations use project management frameworks and methodologies in practice to increase project success.

The case delivered additional insights how organic and mechanistic patterns can be combined but also get a different emphasis depending on the phase. We found much more organic structural elements in the planning and post-shutdown than during the execution. Organic patterns during planning and post-shutdown were used to allow exploration while mechanistic elements fostered exploitation. During the execution the focus was mainly on the mechanistic elements considering the focus was mainly on exploitation. There was much more centralization, a taller hierarchy and the communication was mainly mechanistic (e.g. by means of work permits) combined with organic communication patterns such as the daily TAR meetings and continuous informal contacts on site. Bedford and Malmi (2015) referred to Davila, Foster et al. (2009) who indicated that organic patterns facilitate the generation of new knowledge whereas flexible bureaucracies were useful to flexibly exploit current knowledge. This is now substantiated by this case study. Furthermore we retrieved as described by Bedford and Malmi (2015) that mechanistic structures can be combined with socio-ideological controls that foster the internationalization of shared beliefs and values and confirm their proposition that bureaucratic and socio-ideological controls can together be effective in relatively dynamic and complex conditions.

Performance pay for contractors and staff members of ChemBE demonstrated effective both ex-ante and ex-post (Flamholtz, Das et al. 1985). Nevertheless, Bedford and Malmi (2015) emphasized the importance of intrinsic rewards, which we retrieved very effective in the case. Socio-ideological control was used to let contractors focus on safe, qualitative and efficient work execution. The shared norms, values and ideas among ChemBE employees stimulated them to optimally combine exploration and exploitation during the planning, exploitation during the execution and exploration and exploitation during the post-shutdown. The use of performance pay for contractors let them focus on short-term performance targets in line with March (1991).

As discussed above socio-ideological controls were effective in combination with policies and procedures (Alvesson and Kärreman 2004) and with accounting (Davila, Foster et al. 2009). Furthermore we noticed in line with Flamholtz (1983) that managers did have strong influence on the internationalization of certain norms and values. We found they also have a strong influence on the change in focus during the phases. We also retrieved that a strongly shared culture and socially cohesive organization leads to normative pressure on newcomers from ChemBE or to temporary contractors to behave appropriately. This possible link between a strong culture and social control was already proposed by Bedford and Malmi (2015) and is now confirmed. In addition we found how socio-ideological controls can be used to facilitate changing objectives.

Gibson and Birkinshaw (2004) empirically found the potential positive effects for organizations that successfully combine hard performance management elements such as discipline and stretch with soft

social support elements as support and trust. This case noticed again that both hard performance management and soft social support elements were present and fostered ambidexterity. Furthermore we found these were used with a different intensity depending on the project phase, in line with earlier research findings that switching from time to time between formal structures is far more easy than changing the culture and informal organization (Nickerson and Zenger 2002, Boumgarden, Nickerson et al. 2012). Like this the case provided affirmative practical evidence with regard to Papke-Shields, Beise et al. (2010) their question if soft and hard project management methods can together effectively foster project success.

Furthermore the findings are in line with Tiwana (2008) who empirically demonstrated that project teams need to combine weak/bridging ties to facilitate exploration and strong ties to facilitate exploitation. Also He and Wong (2004, P481) concluded: *"In general, exploration is associated with organic structures, loosely coupled systems, path breaking, improvisation, autonomy and chaos, and emerging markets and technologies. Exploitation is associated with mechanistic structures, tightly coupled systems, path dependence, routinization, control and bureaucracy, and stable markets and technologies."* In line with Tiwana (2008) we noticed that bridging ties allowed to rely on a diverse array of specialized knowledge, perspectives, and skills while strong ties facilitated the integration of all knowledge and capabilities at the project level. We retrieved just as them that both together lead to effective exploration and exploitation and foster ambidexterity. In addition the TAR2015-case demonstrated that different systems, processes, beliefs etc. stimulated individuals to optimally combine exploitation and exploration during their planning efforts, to focus on mainly exploitation during the execution and to contribute to exploitation and exploration post-shutdown by participating in the lessons learned process. During the planning and post-shutdown, socio-ideological controls, policies and procedures and measurement stimulated individuals towards both exploration and exploitation. Hereby mainly hard performance management elements were used to stimulate exploitation. Exploration was mainly stimulated by a more extensive use of soft social support elements as well. The focus on hard performance management and soft social support elements changed as the project progressed as part of the standardized turnaround project process. TAR management furthered the implementation of this standardized turnaround process: they did combine exploration and exploitation themselves, they actively brought up for discussion both, they stimulated individuals to combine both, and they triggered the switches.

TAR management occurs by a hybrid management control package to direct subordinates, but the use of the management controls depends on the project phase. During the planning phase and post-shutdown, the focus is much more on combining exploitation and exploration, whereas the focus during the shutdown is mainly on exploitation. Different controls are emphasized in different phases.

Orthogonal ambidexterity view (4) (5)

Bedford and Malmi (2015) empirically found a widespread package of controls that was a hybridization of multiple control types. Research mentioned that ambidexterity requires seemingly opposing management controls but these packages of diverse controls cause structural tensions (Raisch and Birkinshaw 2008). Our qualitative research now clarifies how these diverse controls co-exist without the previously assumed inherent tensions. Like this our case study evidence substantiates at the operational level to the orthogonal view of ambidexterity.

The case illustrated, in line with Bedford and Malmi (2015), that policies and procedures, measurement and socio-ideological controls can coexist within a combination of organic and mechanistic structures. Earlier theoretical research considers control packages as focused on one single type of controls. For

instance missionary (Mintzberg 1979, Mintzberg 1989) or input/clan (Ouchi 1977, Ouchi 1979, Eisenhardt 1985, Snell 1992) control assume some kind of socio-ideological management controls as incentive for desired behavior. Some literature states that internalization of shared beliefs and values obviates the need for an extensive bureaucratic apparatus of explicit rules and formalized systems of accountability to govern behavior (Alvesson and Lindkvist 1993). Just as Alvesson and Kärreman (2004) we notify a combination of bureaucratic and socio-ideological management controls in a context with dynamic and complex requirements. Like this our case study contributes to research findings of other case studies (e.g. Adler, Goldoftas et al. 1999, Bigley and Roberts 2001, Ahrens and Chapman 2004) that mention the capacity of some organizations to activate bureaucratic structures in a flexible and enabling fashion in a way to perform in highly dynamic environments. The firms in these case studies share conventional hallmarks of bureaucracy such as hierarchy, centralization, and policies and procedures, but without the characteristic rigidities that prevent adaptation to dynamic environmental conditions. Adler, Benner et al. (2009) conclude that a combination of bureaucratization with a high trust social structure can contribute to knowledge generation as long as it has an enabling form. Furthermore there is practical evidence of measurement its important (e.g. Adler, Goldoftas et al. 1999, Bigley and Roberts 2001, Ahrens and Chapman 2004). But whereas measurement in a results oriented bureaucracy is found to lead to “individualizing” effects (Roberts 1991) and is used for control, measurement is not privileged as a source of control in the flexible bureaucracy. Instead measurement is combined with lateral integrative liaison devices and strong socio-ideological controls and like this accounting systems are used to share information that can be “interpreted and understood within the shared context of extensive mutual knowledge” (Roberts and Scapens 1985). Just as Bedford and Malmi (2015) and Speklé (2001) we perceived the usefulness of open sharing of information for exploration. The combination of accounting, lateral integrative devices and socio-ideological controls allowed to use accounting to build shared knowledge within the project team as suggested by Bedford and Malmi (2015). Accounting was thus as expected no stand-alone system but integrated into a control package (Otley and Berry 1980). We also found evidence for Bedford and Malmi (2015) their statement that *“accounting may function as a supplement to the direct observations of top management in the evaluation of task execution, forming part of the feedback loop in refining the specifications of roles and procedures.”* Accounting systems that were dependent on input from employees, as posed by earlier research (Roberts and Scapens 1985, Mouritsen 1999) apparently needed to be combined with strong socio-ideological controls and low performance pay to create the necessary goodwill/belief from employees to give their input and to overcome any information asymmetry problems. Bedford and Malmi (2015) name this use of measurement in combination with socio-ideological controls a “socializing” style of accountability and consider this in line with Mouritsen (1999) as more appropriate to cope with flexibility and adaptation.

We found measurement, policies and procedures and socio-ideological controls were successfully combined within diverse mechanistic and organic structures without the structural tensions expected when combining mechanistic and organic structures (Raisch and Birkinshaw 2008). We even found measurement, policies and procedures and socio-ideological controls could be mutually reinforcing and thus complementary instead of opposing control modes. This substantiates the orthogonal view.

The role of single and double loop learning in fostering exploitation and exploration (6)

We expected a constant single loop learning to update parameters, specific activities etc. within the project turnaround process. This type of exploration was indeed observed at ChemBE. Surprisingly considerable double loop learning occurred as well. It allowed us to unravel how a double loop learning process can occur.

The hybrid management control package fostered learning and changes in turnaround processes. An interesting finding was the presence of single and double loop learning. Single and double loop learning are defined quite similarly by different authors (Argyris 1977, Fiol and Lyles 1985, Kloot 1997). Single loop learning implies minor changes to operating policies while keeping the existing strategies, structures and actions unchanged (Kloot 1997). Parameters are corrected or updated and specific activities or behaviors adjusted within a given organizational structure whereby the given system of rules and these central features are not brought up for discussion (Fiol and Lyles 1985). Double loop learning implies that the underlying strategies, structures and actions are questioned (Kloot 1997). Rather than updating or correcting data or adjusting specific activities or behaviors within a given system of rules, the overall rules, norms or systems are brought up for discussion and the organizational structure is improved.

Just as Duncan (1974) we find in the TAR2015 that the same organizational unit combines different decision making structures for effective learning : centralized, mechanistic structures allow the reinforcement of past behavior (necessary for single-loop learning) while decentralized, organic organizational structures are considered to allow shifts of beliefs and actions and to encourage reflective action-taking (double-loop learning).

Kloot (1997) described that learning can be facilitated by self-disciplined professionals who do rely on self-monitoring and self-regulating mechanisms while senior management still needs to use structured meetings and other management control systems to bring about the necessary discipline, guidance and support (Kloot 1997). Mutual accountability within teams is another management control mentioned by Kloot (1997) to stimulate learning. Furthermore Kloot (1997) found that double loop learning requires reward policies that promote creativity and the development of knowledge and expertise. We now contribute to management control and learning literature by finding a hybrid package able to combine self-discipline and supervision. Furthermore we notice indeed mutual accountability and how a combination of socio-ideological controls and limited financial incentives effectively fosters double-loop learning. In addition Kloot (1997) enumerates the following necessary features that management control packages need to enable double-loop learning and are confirmed in our case : a strongly shared vision, a supportive atmosphere, a corporate learning culture, structures for knowledge transfer, true participative decision-making structures whereby employees are somehow accountable for the outcome, a free and regular accounting information flow throughout the organization, performance measurement systems including both financial and non-financial information, reward systems that create accountability but also “encourage creativity and risk-taking in defined areas of the organization”, training and development, an emphasis on high quality throughout the organization, horizontal control structures (project teams), contingency planning involving different managers and employees to encourage flexibility and creativity in responding to sudden external changes.

Bedford and Malmi (2015) in their paper found that the environment determines the management control package which is a technical-rational perspective (Kloot 1997). They also found that a hybrid package was appropriate in a context with a high outcome measurability and task programmability. We now found evidence that the hybrid management control package determines at least the organization’s perception and controllability of its environment: environmental unpredictability, turbulence and complexity could be controlled better by means of extent planning and measurement efforts combined with single and double loop learning processes. That the management control package determines the environment is called a partial collectivist perspective by Kloot (1997). It is in line with Hopwood (1987) and Dent (1990) who state that organizational change can be proactively managed by management controls that suggest opportunities. Bedford and Malmi (2015) and our

results together suggest that management controls and organizational learning do have a recursive relationship in practice (Gray 1990, Otley and Berry 1994). Nevertheless, care is appropriate considering Bedford and Malmi (2015) use contextual constructs that measure the perception of top management with a survey and this perceived environment can be influenced by the information quality and controllability the control package offers to the top manager. Future research will be needed to clarify if high outcome measurability and task programmability lead to a hybrid package or if a hybrid package leads to high (perceived) outcome measurability and task programmability.

VIII. Conclusion, limitations and directions for future research

A hybridization of management controls, with a combination of all three control modes and changes in emphasis on and use of controls throughout the project cycle, has demonstrated its effectiveness when striving for ambidexterity during a turnaround project (TAR2015) in a chemical firm (nickname ChemBE). The case study research has also clarified how the package fosters successfully ambidexterity. No evidence of tensions within the control package has been found as expected by a two-ends-of-one-continuum-view of ambidexterity, which substantiates that exploration and exploitation can be considered as orthogonal concepts in future ambidexterity research. Another interesting finding is the observed hybrid package its ability to foster both single- and double-loop learning.

We have observed during the case study a hybrid control package similar to the one earlier identified by Bedford and Malmi (2015). The control package includes high use of policies and procedures, measurement and socio-ideological controls in an organizational structure that combines mechanistic and organic patterns. Socio-ideological controls and good leadership (e.g. interactive/diagnostic measurement) are perceived as important success factors to stimulate people to optimally combine exploitation and exploration. The package differs by the lower emphasis on performance pay. The observed hybrid package is perceived as highly effective.

The case study also describes how the package and its individual controls contribute to exploration and exploitation. We find that both individual controls and the joint package contribute to exploration and/or exploitation at the project level .

We find that the emphasis of the use of controls in the project context and their focus on exploration and/or exploitation is not static but changes dynamically during the process cycle of the project.

There was no evidence of tensions in the observed hybrid package, so we do not find evidence for the “two-ends-of-one-continuum” ambidexterity view. It substantiates that exploration and exploitation can be orthogonal concepts. Management controls and control modes are then independent or complementary instead of opposing.

We find that the observed hybrid package stimulates single and double loop learning during the project and that these learning processes foster timely adaptation of the control package to changes in the ambidexterity requirements in the complex dynamic environment. Our results indicate that single and double loop learning serve as a key underlying mechanism mediating the relationship between the observed control package and ambidexterity.

We also conclude that this learning allows to adapt to a changing environment.

Our results contribute to the literature (1) by finding practical evidence where a hybrid package of management controls enables ambidexterity, (2) by explaining how the controls individually and jointly foster exploration and exploitation, (3) by addressing the dynamics during the project cycle in the use of specific controls within the hybrid control package, (4) by retrieving different control modes together without tensions (management control literature) and (5) by not finding any evidence that exploration and exploitation are two-opposing-ends-of-one-continuum which substantiates the use of the orthogonal view in future ambidexterity research, and (6) by expanding our understanding of single and double loop learning in a project context.

We still want to consider some limitations and directions for future research:

We coded all management control practices with the Bedford and Malmi (2015) framework. Hereby the Bedford and Malmi (2015) framework has demonstrated its reliable construct validity. Interviewees understood the different concepts and every mentioned control practices could be neatly categorized into one specific control category of the framework. Whereas Bedford and Malmi (2015) used a theoretical typology, we thus confirmed the categorization is both mutually exclusive and collectively exhaustive. We would recommend to use the framework in other management control studies as well.

Despite the hybrid control package was again observed together, this still leaves the question if there is relatedness between management controls within the package. We describe some combinations that were mentioned as mutually reinforcing. Nevertheless, more (quantitative) research (e.g. experiments) is necessary to test for interrelatedness.

We investigated qualitatively the effects of specific management controls on exploration and/or exploitation. Most interviewees rely on a long experience and consider the observed control package, which is the result of a long optimization process, as highly effective. Nevertheless, these findings are only indicative for causality. Additional research, for instance with experiments, is needed to come up with conclusive proof of causality.

The largest strength of the case study approach was the accessibility of many different data sources (direct observation, physical artefacts, documents as well as diverse interviews) that all converged into the same findings. The search for alternative explanations and attempts to falsify earlier findings, were unsuccessful. The case study design, data collection and data analysis, assure a high reliability and internal validity. The theoretical basis and theoretical proposition, allow even a strong external validity as well. The findings can be generalized to the theoretical proposition that a hybrid package can foster ambidexterity. The case study thus allows analytic generalization instead of statistical generalization (Yin 2013). Nevertheless, we fully acknowledge that the lessons learned from a single case study cannot be straight off generalized to the whole population. Further replication research can be done.

The case study allowed to empirically clarify theory with respect to the management of ambidexterity. The findings are valuable for analytic generalization beyond the ChemBE context into similar contexts, and after additional testing perhaps even totally different contexts, because the possibility to manage ambidexterity with a hybrid package will potentially endure in other contexts as well. We would recommend future research that verifies the effectiveness of a hybrid management control package when aiming at ambidexterity in other situations. The socio-ideological controls demonstrate, for instance, essential for the effectiveness of the hybrid control package. More research is required to find out if a mindset similar to the “TAR mindset” can be triggered in other organizational structures such as traditional organizations

The case study illustrates the importance of socio-ideological controls which are often ignored in other studies. Management controls as selection, socialization, belief systems and social control can probably offer a surplus value in future research as well. These are the glue holding together the otherwise inherent management controls. Furthermore the impact of good leadership is often mentioned as a success factor as well. Again the insertion of this factor into future research about related topics can give additional insights as well.

IX. Appendix

IX.1. Theoretical categorization of management controls. (Bedford and Malmi 2015)

Construct	Theoretical definition
Strategic planning	
Mode	Mode of developing the long-term ends and means of the firm
Participation	Involvement of subordinates in strategic planning processes
Measurement	
Diagnostic	Monitoring activity through deviations from preset standards of performance
Interactive	Regular involvement in subordinate activities by management to encourage debate, creative behaviours and address strategic uncertainties
Tightness	Individual accountability for meeting pre-established performance targets
Cost Control	Financial performance measures of cost efficiency and effectiveness
Measure Diversity	Broad scope and non-financial performance measures
Compensation	
Performance Pay	Performance-contingent rewards and incentives
Subjective/Objective	Method of determining individual compensation
Short/Long Term	Time horizon used for individual compensation
Structure	
Decentralization	Locus of authority – centralised to decentralised
Hierarchy	Vertical differentiation of firm structure – flat to tall
Communication	Nature, direction and content of communication patterns – mechanistic to organic
Integrative Liaison Devices	Horizontal structural arrangements overlaying traditional functional structures
Policies and procedures	
Autonomy	Work activities conducted in the absence of direct observation or involvement by management
Boundary Systems	Statements defining acceptable or unacceptable domains of activity
Standardization	Rules and procedures specifying the means of conducting work activities
Pre-action Reviews	Processes of scrutinization and authorization prior to activity performance
Socio-ideological	
Selection	Search, evaluation and recruitment of employees according to a set of criteria, such as value alignment
Socialization	Processes whereby individuals come to appreciate prevailing norms and beliefs in the firm
Belief Systems	Statements communicating the basic values and premises for action of the firm
Social Control	Reliance on shared values, norms and beliefs to direct work activities

IX.2. Questionnaire 12 in-depth interviews :

We wanted to fully understand which management controls fostered exploration and/or exploitation (June-Oct. 2016). We first explained the terminology of exploration and exploitation. *“Exploitation implies the reuse of past knowledge and capabilities which contributes to efficiency. Exploration implies learning ; the exploration of new knowledge and capabilities contribute to innovation.”* Then, we mainly ask four questions and follow-up questions in the same sequence :

- 1) *“Where were exploration and exploitation present in the TAR-project?”* Follow-up questions relate to what triggered this exploration or exploitation. In this way, we get insight into which management controls they immediately associate with exploration and/or exploitation. *“Can you give examples of exploration and/or exploitation during the turnaround? What fostered this exploitation or exploration?”*
- 2) For each element of the Bedford and Malmi (2015) list of management control mechanisms that was not mentioned spontaneously after the first question was asked, *“was this management practice used during the TAR-project?”* We asked explicitly whether it was used or not, in which stage and if it contributed, hindered or had no effect with regard to exploration and/or exploitation. One follow-up question with regard to management controls was for instance *“does it stimulate exploration and/or exploitation.”*
- 3) We explicitly questioned the effectiveness and efficiency of the turnaround by asking *“How was it possible to reduce the planned shutdown of the turnaround with nearly two weeks and to finish the actual execution even 6 days earlier than planned?”* Follow-up questions were asked such as *“Why was the initial planned shutdown longer and why/how did a second scope challenge round led to this reduction in time?”*
- 4) A last broad question handled the appropriateness of the package, *“Is the used package appropriate?”* We summarized the findings and asked if the interviewee himself considered this package as optimal. *“Do you think the cluster of management controls observed together are appropriate to manage the TAR-projects or not? Do you consider the available management controls appropriate to foster exploration as well as exploitation or not and do you see potential improvements? Do you think of some specific management controls that they reinforce or hinder each other and how do you think all management controls are independent?”*

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Paper 3: Managing job fatigue in project organizations striving for ambidexterity

Managing Job Fatigue in Project Organizations striving for Ambidexterity

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1. Introduction

Project ambidexterity means that a project organization is capable to combine exploration and exploitation within a project. It often implies that **project team members** combine the seemingly opposing needs for exploration and exploitation at the **individual level**, as illustrated by empirical project research (e.g. Liu & Leitner, 2012). **Exploration** means the development or search for new competencies and capabilities. **Exploitation** means applying or even leveraging existing competences and capabilities. Creating an environment that empowers individuals to combine exploration and exploitation in their daily work, is known as **contextual ambidexterity** (Liu & Leitner, 2012). Nevertheless, theories of ambidexterity pose that exploration and exploitation at the individual level imply conflicting goals. It is **difficult for an individual** to develop routines to excel simultaneously at both exploration and exploitation (Gupta, Smith, & Shalley, 2006). The conflicting goals, and job complexity, could affect the well-being of employees (e.g., Chung-Yan, 2010). The **first objective** of this study is to investigate if individual project coworkers that combine exploration and exploitation do face higher levels of Job Fatigue. We rely on goal setting theory of Locke, and Latham (1994), and effects of intra-individual goal conflict. We take the sum of exploration and exploitation at the individual level as a measure for the individual's ambidexterity. The higher the sum, the higher the conflicting goals, the higher the expected Job Fatigue.

Academic literature, and more specific the occupational health literature, offers different studies that rely on **Karasek's demand-control-support model** (Johnson, 1986) to explain job fatigue. In Karasek's model, perceived job fatigue is a function of how demanding a person's job is (job demands), how much control the person has over the activities to perform (job control) and how supported the person feels by his colleagues and supervisors (job social support). In addition to ambidexterity, all three characteristics of project management (Job Demands, Job Control and Job Social Support) are considered. Hence the **second objective** of this study is to investigate among project coworkers if **Karasek's demand-control-support model** (Johnson, 1986) does explain variance in Job Fatigue, next to the variance explained by ambidexterity.

Research should also consider interactions between diverse work characteristics to reconcile inconsistent research findings and to improve the overall understanding of different work characteristics their combined effects on workers (Chung-Yan, 2010, p. 237). The **third objective** is to verify interaction effects between Ambidexterity and Job Demands, Job Control, and Job Social Support. The more an individual combines exploration and exploitation, the higher the conflicting objectives, and this can affect the effects of Job Demands, Job Control, or Job Social Support, on Job Fatigue. We expected that higher Ambidexterity, and thus more conflicting objectives, **reinforce** the unfavorable effect of Job Demands and favorable effect of Job Social Support on Job Fatigue. High Job Demands, or low Job Social Support, may lead to even more Job Fatigue in case of highly conflicting objectives. On the opposite, we expected that higher Ambidexterity, and thus more conflicting objectives, **reduced** the favorable effect of Job Control on Job Fatigue. Higher Job Control may lead to lower Job Fatigue in case of low conflicting objectives. Nevertheless, we expect that this favorable effect may be reduced in case of high ambidexterity and thus highly conflicting objectives.

Figure 9 illustrates the research model. Survey research was set up to collect data from a wide range of employees, working in 10 categories of project businesses. Control variables are added for characteristics of the business context (environmental dynamism and environmental competitiveness). Controlling for the business context when investigating contextual ambidexterity is in line with Raisch, and Birkinshaw (2008) who proposed to consider the specific boundary conditions when doing ambidexterity research, for instance the presence of a heavy competitive and dynamic environment, and who called to do more research on clarification of contextual ambidexterity. Also

four individual characteristics (Job Intrinsic Motivation, Work Hours, Commute Hours, Highest Degree), and one firm-fixed effect were added.

The results show an association between **Ambidexterity** and Job Fatigue. Furthermore, the results show that Karasek's demand-control-support model explains Job Fatigue, similar to previous research. We found that Job fatigue is associated with **higher Job Demands, lower levels of Job Control** and **lower levels of Job Social Support**. The amount of variance explained by Karasek's demand-control-support model was much larger than the amount of variance explained by Ambidexterity. We also found a positive interaction effect between Ambidexterity and Job Control. Ambidexterity weakens the reduction effect of Job Control on Job Fatigue, in line with expectations.

In the next sections, first literature review and hypotheses development are addressed. Then, the methodology is explained. Next, the results are presented. This paper ends with a discussion and conclusion.

2. Literature review and hypotheses development

2.1 Striving for ambidexterity and Job Fatigue

The **first objective** of this study is to investigate if individual project coworkers that combine exploration and exploitation do face higher levels of Job Fatigue.

We follow definitions that consider **exploitation** as the (re)use of earlier acquired knowledge, skills etc. whereas **exploration** implies the development of new knowledge, skills etc. Simsek, Heavey, Veiga, and Souder (2009, p. 867) conclude from earlier work of Tushman, and O'Reilly (1996), Gibson, and Birkinshaw (2004) and He, and Wong (2004) that *"The more prevalent ambidexterity research takes the exploitation-exploration **tradeoff** as a starting point, but argues that firms are most successful when **managers think and act 'ambidextrously'** by trying to attain **high levels of both exploration and exploitation simultaneously**."* Consideration of exploration and exploitation as **orthogonal** activities is nowadays accepted by many ambidexterity researchers (e.g., Gupta et al., 2006; Simsek et al., 2009; Uotila, Maula, Keil, & Zahra, 2009; Turner, Swart, & Maylor, 2013). As Simsek et al. (2009, p. 867) state, ambidexterity is then not about *"achieving the same levels of exploration and exploitation but rather **maximizing the attainment of both**."*

Ambidexterity gets much attention considering its association with organizational performance. *"Conceptual work has been complemented by large-scale **empirical studies** that provide **evidence of organizational ambidexterity's generally positive association with firm performance** (Gibson & Birkinshaw, 2004; He & Wong, 2004; Lubatkin et al., 2006)."* (Raisch, Birkinshaw, Probst, & Tushman, 2009, p. 685) Ambidexterity is associated with **innovation** (Simsek et al., 2009), **financial performance** (Turner et al., 2013; Simsek et al., 2009), **increased organizational durability** (March, 1991; Tushman & O'Reilly, 1996; Turner et al., 2013), **firm performance** (Simsek et al., 2009), **survival** (Simsek et al., 2009), and **sales growth** (He & Wong, 2004).

Previous research has focused on firm-level and business unit level ambidexterity (Raisch & Birkinshaw, 2008; Mom, Van Den Bosch, & Volberde, 2009). Thompson (1967) introduced the **Paradox of Administration**. The paradox of administration has been an enduring ideas in organizational theory (Adler, Goldoftas, & Levine, 1999). It implies that managers must choose between organization designs suited to routine, repetitive tasks and those suited to non-routine, innovative tasks, to strive for either efficiency or flexibility. The underlying idea is that striving for ambidexterity leads to **internal tensions** and **conflicting demands**. It is hard for firms to manage exploration and exploitation concurrently, considering the two drive each other out (Levinthal, and March, 1993; March, 1991). March (1991, p. 72) already indicated that *"the same issues occur at levels of a nested system – at the individual level, the organizational level, and the social system level."* Nevertheless, combining exploration and exploitation simultaneously is easier for a group, organization or another larger system than for individuals; *"One can imagine that it would be difficult for an individual to develop routines to excel simultaneously at both exploration and exploitation."* (Gupta et al., 2006, p. 696). Gupta et al. (2006) indicate that substantial differences in routines and focus on learning, may hinder an individual or even subsystem to combine or even switch between routines of exploration and exploitation. Future research should investigate ambidexterity at the **individual level of analysis** (Gupta et al., 2006; Raisch & Birkinshaw, 2008). Such achievement of ambidexterity at the individual level is defined in literature as **contextual ambidexterity**. It implies that ambidexterity is rooted in an individual's ability to explore and exploit (Raisch et al., 2009). *"Individuals make their own judgments on how to best divide their time between the conflicting demands for alignment and adaptability"* (Raisch et al., 2009, p.689). Hereby individuals' attention to both demands may be either simultaneous or sequential (Raisch et al., 2009).

Mom, van den Bosch, and Volberda (2007, 2009) observed very limited conceptually and empirically validated understanding about ambidexterity at the individual level of analysis. Mom et al. (2007) indicated this as quite remarkable because research in organizational learning, strategy research and technological innovation had earlier demonstrated the importance of managers' individual contributions for firm or unit level exploration and exploitation. Mom, van den Bosch, and Volberda (2007, 2009) found that exploration and exploitation are not mutually exclusive at an individual level and contributed to the understanding how manager's handle ambidexterity using two different perspectives. Mom et al. (2007) found that top-down knowledge inflows are related to exploitative behavior, whereas bottom-up and horizontal knowledge inflows are related to their explorative behavior. Ambidexterity then requires a combination of top-down, bottom-up and horizontal knowledge inflows (Mom et al., 2007). Mom et al. (2009) first proposed three related characteristics managers probably needed to handle ambidexterity. In a second step they developed a model and hypotheses, and in a third step they tested these hypotheses based on a sample. Mom et al. (2009) found that variation in manager's ambidexterity are partly explained by formal structural and personal coordination mechanisms.

So to propose and clarify the three related characteristics of ambidextrous managers, Mom et al. (2009) summarized insights from prior research they used. One of these three handled the conflicting goals an individual manager faces when trying to combine exploration and exploitation (Mom et al., 2009, p. 813):

*“**ambidextrous managers host contradictions** (Smith and Tushman 2005, Tushman and O'Reilly 1996). That is, they have the motivation and ability to be sensitive to, to understand, and to pursue a range of **seemingly conflicting opportunities, needs, and goals** (O'Reilly and Tushman 2004). Related to this, previous research points out the need for ambidextrous managers to **deal with conflict** (Duncan 1976, Floyd and Lane 2000) and to engage in **paradoxical thinking** (Gibson and Birkinshaw 2004, Smith and Tushman 2005).”*

Exploration and exploitation are thus often considered as conflicting objectives. Conflicting goals are discussed in goal-setting theory. Locke, and Latham (2002) summarized 35 years of empirical research on goal-setting theory. A **goal** is the object or aim of an action and **goal-setting theory** clarifies the relationship between conscious performance goals and level of task performance (Locke & Latham, 2002).

Locke, and Latham (2002) retrieved **four mechanisms** by which goals affect performance. First, goals direct attention and effort toward **goal-relevant activities** and away from goal-irrelevant activities. Second, high goals lead to **greater effort** than low goals. Third, harder goals lead to **more persistence**: hard goals prolong effort if participants are allowed to control the time they spend on a task. And fourth, goals lead to the **arousal, discovery, and/or use of task-relevant knowledge and strategies**, and like this indirectly affect performance.

An important conclusion was that that **specific, difficult goals** consistently led to higher performance than just asking people to do their best (Locke & Latham, 2002). The conclusion is twofold. Instead of just urging people to do their best, one has to have **goal specificity**. In addition, not only goals but also **expected goal levels** must be clear to limit the range of acceptable goal levels. Such specific, difficult goals may result in people doing their best.

Specific, difficult goals work best in case people are already trained in the proper strategies to achieve these goals. However, urging people to do their best can lead to better strategies than setting a specific difficult performance goal in case people face **complex tasks** and are **not familiar with the proper strategies to reach the goals**. People then need to use a greater variety of strategies for complex tasks

in a way to develop the needed skills and appropriate task strategies (Locke & Latham, 2002). In that case *“a performance goal can make people so **anxious** to succeed that they scramble to discover strategies in an unsystematic way and fail to learn what is effective. This can create **evaluative pressure** and **performance anxiety**.”* (Locke & Latham, 2002, p. 707) Locke, and Latham (2006) repeated that such search for new knowledge may or may not be successful. Locke, and Latham (2006) concluded that **performance is a function of both ability and motivation**, and thus goal effects depend upon having the **requisite task knowledge and skills** for which they mentioned two possibilities. *“Goals may simply motivate one to use one’s existing ability, may automatically “pull” stored task-relevant knowledge into awareness, and/or may motivate people to search for new knowledge. The latter is most common when people are confronted by new, complex tasks.”* (Locke & Latham, 2006, p. 265)

Conflicting goals are one example of complex tasks that individuals can face. Earlier research of Locke, Smith, Erez, Chah, and Schaffer (1994) handled the effects of **intra-individual goal conflict** on performance. Locke et al. (1994) focused on intra-individual conflict in case individuals must combine a number of tasks or outcomes because multiple goals or tasks exist. Different studies demonstrated that individuals could combine these different goals at the same time or with different degrees of emphasis at different times, but Locke et al. (1994) were the first to **actually measure experienced conflict**. Locke et al. (1994) found that **goal levels were related to performance**. They also noticed that intra-individual conflict is not only between different types of tasks. Sometimes individuals experience conflicts between different types of goals on a single task. Then there is one task, but the conflict is over which performance dimension to emphasize. Also these individuals are required to combine different conflicting goals. Locke et al. (1994) considered quantity vs. quality, and teaching vs. research, and found for both sets of **conflicting goals** that were investigated in their paper that conflict was negatively related to at least one performance outcome. **Role conflict** is closely related to goal conflict (Locke et al., 1994). A **role** is the wider concept and refers to the expected ways of acting for an individual in a given context. A **goal** is then the narrower concept and refers to the specific outcome or end that an individual is trying to achieve. Both role conflicts and goal conflicts can occur. Locke et al. (1994) indicated **pressure** as the main source of intra-individual conflict between goals or roles. A role or goal holder experiences internal or external pressure to take actions or achieve outcomes that are partly or wholly incompatible.

An unexpected finding of Locke et al. (1994) was that the goal conflict effect was **not mediated** by commitment, goal priority, goal level or strategies. Locke et al. (1994) neither found **moderator** relationships/interaction effects. **They asked for more research to find out what does mediate the effects of goal conflict on performance.** We **hypothesize** that **Ambidexterity** may trigger **Job Fatigue**, and from literature we know that mental well-being does have an effect on **performance**. Wright, and Cropanzano (1998) refer to diverse studies that found **emotional exhaustion** to be destructive for both the **quality of work life** as well as optimal **organizational functioning**. Employees can face somatic difficulties, e.g. colds, headaches, sleep disturbances..., whereas organizations suffer from employees’ suboptimal work attitudes, turnover intentions, counterproductive work behavior, and performance. Wright, and Cropanzano (1998) could not find a relation between emotional exhaustion and job satisfaction in their study, but did find that **emotionally exhausted employees** exhibit **diminished job performance** and **quit their job more often**. Cropanzano, and Wright (1999) found again that more happy workers perform better. They even retrieved the performance effect of worker happiness when using intervals between assessment of well-being and performance as long as one year. The happy-productive worker thesis was confirmed: *“a tendency to experience positive emotional states while not experiencing negative emotional states should produce higher levels of work performance.”* (Cropanzano & Wright, 1999, p. 252)

In this study exploration and exploitation are considered as conflicting goals. Striving for ambidexterity, and combining conflicting goals, could exhaust individual coworkers. Simsek et al. (2009, p. 869) mentioned *“Concurrently pursuing exploitation and exploration harmoniously within a single organizational unit is inherently challenging, because each competes for scarce resources, leading to **conflicts, contradictions, and inconsistencies**. In the absence of partitioning, this pursuit becomes intertwined in the ongoing operating and strategic activities of the unit in its culture, structure, and systems; placing a **premium on its members’ integrative abilities**.”* (2009). Whereas Karasek (1979) initially used the term “exhaustion”, we use **Job fatigue** which measures the extent to which employees feel fatigued at the end of a working day and have a need to recover (Van Yperen & Hagedoorn, 2003). We verify the **relation** between an individual’s **striving for ambidexterity**, and thus combining of conflicting goals, and **Job Fatigue**.

We hypothesize for project contexts demanding ambidexterity:

H1: Individuals with a **higher level of ambidexterity** experience a **higher job fatigue**.

Does an individual’s striving for ambidexterity has a **significantly positive correlation** with **job fatigue**? This would mean that the ability to combine exploitation and exploration at the individual level, results in an higher (i.e. unfavorable) job fatigue for the individual.

2.2 Karasek’s Model and Job Fatigue

The **second objective** of this study is to investigate among project coworkers if **Karasek’s demand-control-support model** (Johnson, 1986) does explain variance in Job Fatigue, above the variance explained by ambidexterity. We preferred **Karasek’s demand-control-support model** because it often recurred and earlier prove its relevance to explain variances in Job Fatigue. We found diverse other studies in the occupational health literature as well that focused on mental well-being of workers.

In the **effort-reward imbalance (ERI) at work model**, *“chronic work-related stress is identified as non-reciprocity or imbalance between high efforts spent and low rewards received”* (Siegrist, Starke, Chandola, Godin, Marmot, Niedhammer, & Peter, 2004, p. 1483).

The **conservation of resources theory (COR)** is a theoretical framework that attributed **emotional exhaustion** to an **imbalance between resources and work demands**. *“The major **demands** of work include role ambiguity, role conflict, stressful events, heavy workload, and pressure. The major **resources** include social support from various sources; job enhancement opportunities, such as control, participation in decision making, and autonomy; and reinforcement contingencies (Burke & Richardsen, 1993; Cordes & Dougherty, 1993).”* (Lee & Ashforth, 1996, p. 123). Emotional exhaustion is one of the three dimensions of burnout (Maslach, 1982). The theory suggests that burnouts occur due to the loss of valued resources, inadequate resources to meet demands, or resources that do not yield the anticipated returns (Lee & Ashforth, 1996). Wright, and Cropanzano (1998), using the COR model as well, found that **emotionally exhausted employees** exhibit **diminished job performance**.

Another model is the **effort recovery model** (Meijman & Mulder, 1998): an individual’s recovery from job efforts plays a role when predicting individual health and well-being. Individuals that spend work efforts, experience certain **load reactions** in the individual (Sonnentag, 2001). Normally load reactions, and **fatigue** and **other effects of stressful situations**, are **reduced by means of a recovery process** when the individual is not facing work demands (Sonnentag, 2001). **Longer term negative effects**, such as **impaired well-being** and **health problems**, occur when demands continue and no recovery occurs (Sonnentag, 2001).

The **Job Demands-Resources (JD-R)** model incorporates many different working conditions, and considers both negative and positive indicators of employee well-being (Bakker & Demerouti, 2007). Risk factors associated with job stress are classified into two general categories: job demands and job resources. **Job demands** are *“those physical, psychological, social, or organizational aspects of the job that require sustained physical and/or psychological (cognitive and emotional) effort or skills and are therefore associated with certain physiological and/or psychological costs”* (Bakker & Demerouti, 2007, p. 312). Job demands that require high effort, in combination with inadequate recovery, may turn into stressors. Physical, psychological, social, or organizational aspects of the job, are considered as **job resources** if these demonstrate one or more of the following three characteristics (Bakker & Demerouti, 2007, p. 312): *“Functional in achieving work goals”, “Reduce job demands and the associated physiological and psychological costs”, and “Stimulate personal growth, learning, and development”*. Support, autonomy, feedback etc. are examples. .

The **Job Demand-Control (JD-C) Model** has been used extensively in current job stress research (Siegrist et al., 2004). The enhanced version is the Job demand-control-support model. Karasek developed the **demand-control-model** (Karasek, 1979) and later Johnson (1986) added **social support**. Academic literature, and more specific the occupational health literature, offers different studies that rely on **Karasek’s demand-control-support model** (Johnson, 1986) to explain job fatigue. We will test if Job Demands, Job Control, and Job Social Support experienced by individuals explain any additional differences in individuals’ **Job Fatigue** while already considering that these individuals are striving for ambidexterity.

Job Demands refer to the variable that measures certain stress sources (stressors) present in the work environment, such as the levels of work load, the degree to which an employee has to work fast and hard, or the lack of time to execute the job (Karasek, 1979; Van Yperen & Hagedoorn, 2003). **Job control** considers the coworker his control with regard to both timing as well as method of own activities (Wall, Jackson, Mullarkey, & Parker, 1996; Yperen & Hagedoorn, 2003). **Job Social Support** is the helpful social interaction on the job with both co-workers and supervisors (Yperen & Hagedoorn, 2003; Theorell & Karasek, 1996). Theorell, and Karasek (1996) relied on the extended Karasek demand-control-support model to investigate their respective and combined effects on **job strains** and **coworker well-being**. Van Yperen, and Hagedoorn (2003) also relied on this extended Karasek demand-control-support model to verify the interaction between job demands, job control, and job social support on **intrinsic motivation** and **job fatigue** simultaneously.

Karasek (1979) considered jobs with high demands but low control as high strain jobs. Increasing **job demands** were found to produce **job fatigue** and a **need to recover** (Van Yperen & Janssen, 2002). High job demands are thus associated with negative health-related outcomes. Employees who do not have the **job control** to handle these pressuring demands, pen up stress internally and end up fatigued and exhausted (Karasek, 1979). Karasek (1979) indicated the tempering influence of **job control** with regard to the effect between on the one hand job demands and on the other hand stress, job fatigue or exhaustion. Van Yperen, and Hagedoorn (2003) included besides **job control** also **job social support**, in addition to job demands. Van Yperen, and Hagedoorn (2003) tested if **job control** could enable recovery during the working day and like this prevent the accumulation of **job fatigue**. Van Yperen, and Hagedoorn (2003) retrieved the tempering effect of **job control** on the correlation between **job demands** and negative health-related outcomes such as **Job Fatigue**. They again found that increasing **job control** can **reduce job fatigue** in case of **high demand jobs**. They could **not** find an **effect** of **Job Social Support** on the correlation between **job demands** and Job Fatigue. They concluded: *“As job demands increase, job control is needed to limit fatigue.”* (Van Yperen & Hagedoorn, 2003, p. 344). They did find as well that both **Job Control** and **Job Social Support** had a negative main effect on **Job**

Fatigue. We will add the main effects of Job Demands, Job Control, and Job Social Support to our research model. Replicating **earlier findings**, the following hypotheses are added:

H2: **Job Demands** has a **positive (i.e. unfavorable)** impact on **Job Fatigue**

H3: **Job Control** has a **negative (i.e. favorable)** impact on **Job Fatigue**

H4: **Job Social Support** has a **negative (i.e. favorable)** impact on **Job Fatigue**

2.3 Interactions of Ambidexterity and Karasek's Model

The **third objective** is to verify **interaction effects** between Ambidexterity and Job Demands, Job Control, or Job Social Support.

Occupational health literature paid attention to the psychological and physical effects of the cognitive and social demands in the workplace (Chung-Yan, 2010). However, *“more research is required concentrating on the **interactions** between elements of **work characteristics** and their effects on workers”*, because it could *“help to reconcile inconsistent research findings and lead to a fuller understanding of the impact of job elements on workers”* (Chung-Yan, 2010, p. 237).

There are different reasons to hypothesize that Ambidexterity may influence the effects of Job Demands, Job Control, or Job Social Support on Job Fatigue.

There is the relationship of **goal difficulty** to performance addressed by Locke, and Latham (2002). They found a positive, linear function: *“the highest or most difficult goals produced the highest levels of effort and performance”* (Locke & Latham, 2002, p. 705). Despite hard goals prolong effort, there is often a **trade-off** in work between time and intensity of effort (Locke & Latham, 2002). *“Faced with a difficult goal, it is possible to work faster and more intensely for a short period or to work more slowly and less intensely for a long period.”* (Locke & Latham, 2002, p. 707) Locke, and Latham (2002) also indicate the existence of other interaction effects. They (2002, p. 706) observed, for instance, that performance could level off or even decrease *“when the **limits of ability** were reached or when **commitment to a highly difficult goal lapsed.**”* Locke, and Latham (2002) indicated that **harder goals** lead to higher persistence in case participants are **allowed to control the time they spend** on a task. Locke et al. (1994) earlier mentioned similar restrictions. They gave two requirements to reach the performance effects of specific, difficult goals: *“individuals have **adequate ability** and **situational constraints do not prohibit task-relevant performance**”* (Locke et al., 1994, p. 67). Another requirement is that *“**appropriate task strategies** are used when the task is complex”* (Locke et al., 1994, p. 67).

Ambidexterity implies some complex, conflicting objectives, e.g. one project (task) for which both exploration and exploitation are needed. An individual that must combine conflicting goals can experience this as one cause of goal difficulty. Goal difficulty can also be due to **Job Demands**. Ability, control about time spent, and situational constraints are similar to **Job Control**. **Job Social Support**-mechanisms help an individual to select the appropriate task strategies in case he/she is struggling with conflicting goals as exploration and exploitation. On the one hand Karasek's demand-control-support model thus explains variances in Job Fatigue. On the other hand **goal-setting theory** already indicates that characteristics similar to Ambidexterity, Job Demands, Job Control, and Job Social Support, can have related influences on the level of effort and performance. **A remaining question stays if increasing conflicting goals, which leads to higher job difficulty, has an influence on the influence of Job Demands, Job Control, or Job Social Support on Job Fatigue.**

First, we expect a more unfavourable impact of Job Demands on Job Fatigue in case of high rather than low ambidexterity. Higher Job Demands may lead to even more Job Fatigue if individuals must perform on highly conflicting goals. Job demands due to a high-work load, working fast and hard, and a lack of time may be even more exhausting in case individuals face highly conflicting goals. **Second**, we expect a less favourable impact of Job Control on Job Fatigue in case of high rather than low ambidexterity. An individual who combines highly conflicting goals may not be able to fully use increased Job Control to optimize efforts for exploration or exploitation once the limits of ability are reached. **Third**, we do expect a more favourable impact of Job Social Support on Job Fatigue in case of high rather than low ambidexterity. An individual who combines highly conflicting goals may have a higher need for Job Social Support to select the right strategies. Social interaction with colleagues and supervisors could be helpful to handle conflicting goals. The higher an individual combines conflicting goals, the more likely the individual needs Job Social Support when trying to combine exploration or exploitation.

H5: The **positive (i.e. unfavorable)** impact of **Job Demands** on **Job Fatigue**, is **reinforced** when **Ambidexterity** is high.

H6: The **negative (i.e. favorable)** impact of **Job Control** on **Job Fatigue**, is **reduced** when ambidexterity is high.

H7: The **negative (i.e. favorable)** impact of **Job Social Support** on **Job Fatigue**, is **reinforced** when ambidexterity is high.

2.4 Control variables

We consider one control variable measuring the job intrinsic motivation of the individual and two control variables that measure characteristics of the business context, i.e. environmental dynamism and environmental competitiveness. Work hours, Commute hours, Gender and Highest Degree are included as control variables as well. In addition, there is one dummy variable for firm fixed effects of FirmX where a considerable part of the respondents work.

When scrutinizing the construct for Intrinsic Motivation used by Van Yperen, and Hagedoorn (2003), we noticed that **diverse elements** were included that measured either intrinsic (**autonomous**) motivation or job satisfaction. **Job satisfaction** concerns happiness by the job. It can be operationalized by measuring satisfaction with the work itself, with coworkers, and with supervision (Wright & Cropanzano, 2000; Wright, Cropanzano, & Bonett, 2007). Nevertheless, happiness by the job can be influenced by management. **Intrinsic motivation** is described by Van Yperen, and Hagedoorn (2003, p.340) as *“the motivation to perform an activity for itself, in order to experience the pleasure and satisfaction inherent in the activity”*. It is important to distinguish intrinsic motivation from extrinsic motivation. Ryan, and Deci (2000a) refer to the classic definitions in Self-Determination Theory where intrinsic and extrinsic motivation are distinguished by the reasons or goals that give rise to an action. **Extrinsic motivation** refers to doing something in order to attain a separable outcome (Ryan & Deci, 2000a., p.55; Ryan & Deci, 2000b., p.71). **Intrinsic motivation** refers to doing something because it is inherently interesting, enjoyable or satisfying (Ryan & Deci, 2000a., p.55; Ryan & Deci, 2000b., p.71). Which activities a certain individual considers as interesting, enjoyable or satisfying is thus inherent to the personal preferences, and not stipulated by management. To improve conceptual clarity, we include one separate measure for **Intrinsic Motivation as control variable in the main model** which differs from the one used by Van Yperen, and Hagedoorn (2003). We further limit, in line with earlier research, intrinsic motivation to the tendency of an individual to do explorative activities. Ryan, and Deci (2000b, p.70) even defined intrinsic motivation as *“the inherent tendency to seek out novelty and challenges, to extend and exercise one’s capacities, to explore, and to learn”*, which clearly defines

some inherent tendency towards exploration. Besides Intrinsic Motivation, we consider **environmental dynamism** and **environmental competitiveness** as control variables, just as Work Hours, Commute Hours, Gender, Highest Degree, and a control variable for firm fixed effects.

3. Methodology

3.1 Data collection

To test the hypotheses, survey research was conducted. The population of this study concerns employees who are involved in business projects. The capability to combine **exploration and exploitation** is often required **at the project level** (Maylor, Brady, Cooke-Davies, & Hodgson, 2006; Winter, Andersen, Elvin, & Levene, 2006; Geraldi, Maylor, & Williams, 2011; Liu & Leitner 2012; Eriksson, 2013; Turner, Maylor, & Swart, 2015). Projects face unique challenges so exploration is necessary to find solutions for these problems. Projects are also restricted by tight constraints (e.g. scope, time and cost) so exploitation is necessary to improve efficiency (Liu & Leitner, 2012; Eriksson, 2013). A combined need for exploration and exploitation, makes the project management context an excellent area for ambidexterity research (Geraldi, Kutsch, & Turner, 2011). Nevertheless, Tiwana (2008) indicates a lack of pure project-level investigations in which ambidexterity is studied within projects.

The respondents were approached by sharing an invitation with a clear description (1) via the linked-in profile of one of the researchers, (2) via a newsletter for lawyers, (3) via three internal company mailings¹. The links were open for 3 weeks. In total 187 respondents filled in the full questionnaire. Only two constructs allowed missing values. Answers were only saved after completion of the entire survey.

The invitation explained that the *survey*² aims at a better understanding of the **stress level** and **job activities within projects**. We explicitly mentioned that the questionnaire was intended for **employees** and **managers** who are often **involved in projects**. A project was defined as each temporary endeavor undertaken to deliver one or more products or services for a specified business case. We explicitly targeted certain project businesses, in particular accountancy and tax, corporate finance, engineering and construction, financial audit, IT (consultancy), legal services, management and business consultancy, marketing and research and development.

A broad group of individual coworkers, firms and businesses allows variation of the included variables. We include different manufacturing and service industries which helps to minimize industry specific effects and to optimize external validity (Gibson & Birkinshaw, 2004; Mom et al., 2009). The data collection approach thus increases the possibility for variance in both the dependent and the explanatory variables (Ghoshal & Bartlett, 1994; McDonough & Leifer, 1983; Mom et al., 2009).

The **anonymity** of all participants was ensured. All **data was collected anonymously** and responses staid disconnected from respondents at all time. As researchers we used the data for statistical analysis and only general findings were disclosed.

187 respondents filled in the questionnaire. Nevertheless, 4 respondents (IDnumber: 66; 88, 95, and 102) indicated they had no colleagues nor supervisors and these were excluded from the analysis. One survey missed initially the option “Not applicable” with regard to social support. For the 4 people that

¹ Results do not differ for different collection methods

² Survey is added in appendix

had already filled in the survey, we replaced for Q6.3.JSSUP_1 and Q6.3.JSSUP_2 value 1 “Never” in 8 “N/A” to consider it as missing value (person 2/3/4). Experienced lawyers often do not have a boss, but do collaborate with fellow active business partners. Furthermore, 2 respondents had not indicated their gender (IDnumber: 115, and 119) and 2 had not indicated their highest degree (IDnumber : 73, and 119). Missing value analysis with the EM-method in SPSS is used to test if (quantitative) missing data is completely at random. Little’s MCAR-test uses Bartlett’s test of sphericity to test if data missing is at random. No evidence is found against the null hypothesis that data missing is at random.³ Subsequently the missing values for the 3 cases of these control variables were filled in by replacing the missing value by the median. We preferred the median above the mean because the categorical nature of both control variables.

In total 183 complete cases could be used for analysis. Cases 66, 88, 95 and 102 were excluded.

3.2 Survey development & Measures

The survey has been pretested by pilot testing. A dozen of researchers and practitioners, not involved in the later survey, were asked to fill in the survey and give feedback with regard to the clarity and unequivocalness of the questions.

The **dependent variable** of the model is *Job Fatigue*. As **independent variables** we consider one combined construct that measures *ambidexterity* by the individual as well as the *Job Demands, Job Control and Job Social Support* experienced by the individual. There are also interaction terms between *Ambidexterity* and *Job Demands, Job Control and Job Social Support*. As **control variables** we consider *Job Intrinsic Motivation* which controls for individual differences as well as *Environmental Dynamism and Environmental Competitiveness* that control for two aspects of the business context. *Work Hours, Commute Hours, and Gender, and Highest Degree*, control for characteristics at the individual level. Variables can be categorized into four categories. Seven variables concern *individual characteristics*: Job Fatigue, Ambidexterity, Job Intrinsic Motivation, Gender, Highest Degree, Work Hours and Commute Hours. Three variables concern *project management characteristics*: Job Demands, Job Control and Job Social Support. And two variables concern *characteristics of the business context*: Environmental Dynamism and Environmental Competitiveness.

Two continuous variables *Work Hours, Commute Hours*, and two dummy variables *Gender, and Highest Degree* are one-item measures and are not included in the **exploratory analysis**⁴. Most constructs are measured with 7-point Likert scales: Job Fatigue, Exploitation, Exploration, Job Demands, Job Control, Job Social Support, Job Intrinsic Motivation, Environmental Dynamism, and Environmental Competitiveness. The seven-point likert scales we use for these diverse variables are often “in between” ordinal and interval. Nevertheless, we will assume for all variables that the intervals are equally spaced in order to be able to use statistics that assume the variable is an interval variable. We run a **principal component analysis** with Direct Oblimin and Varimax rotation of all items of these independent, dependent and control variables together, while using a fixed number of factors equal to nine considering the nine theoretical constructs. We decided to leave out the reversed item of **Environmental Dynamism**, the two reversed items of **Job Demands**, and one reversed item of **Job Control**. Two items with a deficient loading and unacceptable cross-loading (EXPL item 1 and EXPL item 3) were deleted as well. Before excluding these two items and the reversed items, we had verified if these were really necessary for content validity and if there could be a reason for a low convergent,

³ A limitation, however, is that the dummy’s for Gender and the Dr. or Master-level are both categorical dichotomous variables and not quantitative variables as preferable for the test.

⁴ One can find the exploratory factor analysis in **Table 12**. Also the Cronbach’s alphas of the reliability analysis are added in **Table 12**.

and discriminant validity, or the reliability issues in case of the exploitation-items. We think both exploitation items are difficult to interpret univocally. For the first item, we would propose to change it in “Activities for which you can rely on your earlier experience”. For the third item, we would propose to split the statements into “Activities which serve existing customers” and “Activities where you deliver existing services or products”. We do not consider the deletion of the items problematic for content validity.⁵ After deletion of the reversed items as well as the first and third item of the Exploitation-measure, all the respective items loaded on the respective constructs when doing **principal component analysis** with **Direct Oblimin rotation**. The **oblique rotation with Direct Oblimin** demonstrated all factor correlations between independent and control variables were below .32, so we used an orthogonal rotation as well. This **Varimax rotation** supported the results⁶. KMO and Bartlett’s was always significant (but there were no missing values), **communalities** were acceptable and total variance explained steadily approximated 60%.

The **convergent** validity is ok: all items load on the appropriate factors. **Discriminant** validity is also ok: the pattern matrix shows that **cross-loadings are lower than loadings on the construct**. The good convergent and discriminant validity are illustrated by the exploratory factor analysis with Varimax rotation. **Job Fatigue**-items load between .559 and .822 on the Job Fatigue-component. Cross-loadings on other components are not higher than .328. **Explorative Activities**-items load between .621 and .756 on the Explorative Activities-component. Cross-loadings on other components are not higher than|.367|. **Exploitative Activities**-items load between .585 and .796 on the Exploitative Activities-component. Cross-loadings on other components are not higher than .195. **Job Demands** -items load between .501 and .871 on the Job Demands-component. Cross-loadings on the eight other components are not higher than .413. **Job Control**-items load between .443 and .806 on the Job Control-component. Cross-loadings on the eight other components are not higher than .298. **Job Social Support**-items load between .689 and .863 on the Job Social Support -component. Cross-loadings on the eight other components are not higher than|.323|. **Environmental Dynamism**-items load between .592 and .732 on the Environmental Dynamism-component. Cross-loadings on other components are not higher than .362. **Environmental Competitiveness**-items load between .652 and .874 on the Environmental Competitiveness-component. Cross-loadings on other components are not higher than .309. **Job Intrinsic Motivation**-items load between .611 and .778 on the Job Intrinsic Motivation-component. Cross-loadings on other components are not higher than .300. The **correlation matrix** shows no correlations between independent and control variables above .5. **We control for each construct its Cronbach’s alpha as well as its Cronbach’s alpha if items are deleted**. All Cronbach’s alpha’s showed a satisfying **reliability**. Item scores are averaged per construct into single indicators per constructs. These means are used in the analyses.

The **dependent variable** of the model was **job fatigue**. The measure of Van Yperen, and Hagedoorn (2003) for Job fatigue is an eleven-item measure and respondents score the 11 items on a two-point response scale (1=“no”, 2=“yes”) indicating if each item applies to them. Van Yperen, and Hagedoorn (2003) rely on the Kuder-Richardson formula 20 (KR-20; Nunnally & Bernstein, 1994) to test the internal consistency of this scale with dichotomous items. Yperen, and Hagedoorn (2003) found an internal consistency equivalent with a Cronbach’s alpha of 0.87. **We use the same eleven items but prefer a modified seven-point Likert scale (ranging from 1=“strongly disagree” to 7=“strongly agree”) instead of this scale with dichotomous items**. We find without the reversed item a Cronbach’s alpha of **0.907**.

⁵ If items are not deleted, the findings stay the same.

⁶ Conclusions remain without influential outliers as well.

To measure *Ambidexterity*, we first needed to define *exploration* and *exploitation* at the individual coworker level. Earlier research (e.g. Gibson & Birkinshaw, 2004; He & Wong, 2004; Lubatkin, Simsek, Ling, & Veiga, 2006) constructs ambidexterity measures at the firm or business unit level by combination of measures of exploration and exploitation. Considering a lack of ambidexterity scales at the individual level, Mom et al. (2009) constructed one to measure managers' ambidexterity. Exploration and exploitation are each measured by a 7-items construct that interrogates the explorative or exploitative activities. To measure "exploration" we reuse the 7-items construct of Mom et al. (2009). We find a Cronbach's alpha of 0.821 in line with the Cronbach's alpha of 0.90 in Mom et al. (2009). Exploitation is a broad concept with a variety of items. To measure "exploitation" we reuse the 7-items construct of Mom et al. (2009). The initial Cronbach's alpha is 0.647. We exclude one item (EXPL1) considering the potential higher Cronbach's alpha if items are deleted and the exploratory analysis which indicates a low communality and a problematic cross-loading on other constructs. The new Cronbach alpha's is 0.654. In addition, we exclude a second item (EXPL3) considering the potential higher Cronbach's alpha if the item is deleted (0.670) and the exploratory analysis which indicates a low communality and a high cross-loading on other constructs. We end up with a Cronbach alpha's of **.670** which is lower than the Cronbach's alpha of 0.87 Mom et al. (2009) found for "a manager's exploitation activities". A reason for this may be that we focus on demanding project businesses and the lower variability influences reliability.

We compose *Ambidexterity* as the sum of *exploration* and *exploitation*. There are many researchers that combine exploration and exploitation measures to assess ambidexterity (e.g. Gibson & Birkinshaw, 2004; He & Wong, 2004; Lubatkin et al., 2006). Addition sum, subtraction sum or multiplication are some possibilities. Gibson & Birkinshaw (2004) and Mom et al. (2009) focused on ambidextrous behavior of individuals and assessed the ambidexterity at the individual level by multiplicative interaction between coworkers' exploration and exploitation. We also use a combination of a coworkers' exploration and exploitation, but do prefer its sum instead of its multiplication. Using the sum also makes sense considering it's a well-balanced measure for the combination of exploration and exploitation by the individual.⁷ The higher the sum, the higher the conflicting objectives.

Job Demands, Job Control and Job Social Support are measured by means of the same measures Van Yperen, and Hagedoorn (2003) relied on. Van Yperen, and Hagedoorn (2003) their three constructs consist of different items that needed to be scored on a four-point response scale (1="never", 2="sometimes", 3="often", 4="always"). **Nevertheless, in this study, for all three measures a seven-point Likert scale, ranging from 1 to 7 was used for consistency with the other variables included in this research.** **Job Demands** is measured by means of 11 items based on Van Yperen, and Hagedoorn (2003). The two reversed items were left out of the initial 11 items-construct with a Cronbach's alpha of 0.893. The final 9-items constructs had a Cronbach's alpha of **.899** which is in line with the Cronbach's alpha of .90 in Van Yperen, and Hagedoorn (2003). Also **Job Control** is measured by means of 11 items based on Van Yperen, and Hagedoorn (2003). The 11-items constructs had a Cronbach's alpha of **.887** which is in line with the Cronbach's alpha of .90 in Van Yperen, and Hagedoorn (2003). **Job Social Support** was measured by four items that handle social support from both supervisors and colleagues in line with Van Yperen, and Hagedoorn (2003). They referred to earlier research that indicates a moderate to high correlation between supervisory and coworker support. Therefore, they preferred one measure of the perceived availability of instrumental support on the job without separation. No items needed to be left out. The measure demonstrated a Cronbach's alpha of **.860**

⁷ A multiplication of Exploration and Exploitation results in an insignificant effect of Ambidexterity on Job Fatigue.

which is in line with the Cronbach's alpha of .80 in Van Yperen, and Hagedoorn (2003). Missing values are only possible for Job Social Support. It indicates that a respondent has not answered (N/A) the questions with regard to colleagues and/or direct supervision considering (s)he has no colleagues and/or direct supervisor. We do not delete these cases as long we have values for either colleagues or direct supervisors, and we are able to average the non-missing values.

Multiple-item **control variables** concerned: ***Intrinsic Motivation, Environmental Dynamism and Environmental Competitiveness.***

Vallerand (1997) offers an overview of different studies which use the **Intrinsic Motivation** Scale that he and other colleagues developed and validated. Three types of intrinsic motivation - intrinsic motivation to know, to accomplish things and to experience stimulation - were mostly combined in one measure by averaging the values for the 12 items as proposed by earlier research. Vallerand (1997) indicated this procedure as preferable considering different types of intrinsic motivation do have similar relationships with various other antecedents and consequences. **The Intrinsic motivation-measure used by Van Yperen, and Hagedoorn (2003) had twelve items which needed to be scored on a seven-point response scale ranging from 1="strongly disagree" to 7="strongly agree".** Van Yperen, and Hagedoorn (2003) found a Cronbach's alpha of 0.88 for the measure. Nevertheless, the used construct contains some items that resemble job satisfaction (e.g. 'For the satisfaction I feel/experience...', 'Because I feel pleasant in my job.', ...). Furthermore, the definition and construct used by Van Yperen, and Hagedoorn (2003) does not distinguish between exploration and exploitation whereas Ryan, and Deci (2000b) do focus on exploration. We do not want to include elements that resemble job satisfaction and we want to follow the focus on exploration in line with Ryan, and Deci (2000b). As a result, **we measure employee intrinsic motivation at work with another 3-item construct used by Zhang, and Bartol (2010).** Individual respondents were asked how much they enjoy finding solutions to complex problems, creating new procedures for work tasks and improving existing processes or products. This clearly defines some inherent tendency towards exploration. Zhang, and Bartol (2010) found a Cronbach alpha of .82 in their research that was higher than the internal consistency ($\alpha=0.74$) Tierney, Farmer, and Graen (1999) found earlier with a similar more extent 5-item, 6-point scale instrument. Whereas Zhang, and Bartol (2010) use a 5-point Likert-type scale ranging from "strongly disagree" to "strongly agree", we use a 7-point Likert-type scale. The measure demonstrated a Cronbach's alpha of **0.671**.

Environmental dynamism measures the rate of change and the instability of the external environment. It is used in different earlier studies: Dill (1958), Volberda, and Van Bruggen (1997), Jansen, Van Den Bosch, and Volberda (2005a), Jansen, Van Den Bosch, and Volberda (2006), Mom et al. (2009), Jansen, Vera, and Crossan (2009)... **Environmental competitiveness** refers to the degree of competition in the external environment. It is used in different earlier studies as well: Birkinshaw, Hood, and Jonsson (1998), Jaworski, and Kohli (1993), Jansen et al. (2005), Jansen et al. (2006). Environmental dynamism is measured by the five-item measure used in Jansen et al. (2006) and Jansen et al. (2009). Some small adjustments were done to let the five-item measure fit the individual coworker point of view. We find an initial Cronbach's alpha of 0.789. After deletion of the reversed item we end with a Cronbach's alpha of **0.796**. This is in line with earlier research, with Cronbach's Alpha of 0.87 (Jansen et al., 2006) in a study linking formal and informal coordination mechanisms with exploratory and exploitative innovation and of 0.91 (Jansen et al., 2009) in a study linking transformational and transactional behaviors of strategic leaders to exploratory and exploitative innovation.

Environmental competitiveness is measured by the four-item measure used by Jansen et al. (2005), and Jansen et al. (2006). Again some small adjustments were done to let the five-item measure fit the individual coworker point of view. The Cronbach's alpha of **0.880** is very good, no items are left out.

This is again in line with Jansen et al. (2005) who already found this scale for competitiveness to be unidimensional and reliable ($\alpha = 0.85$) when exploring how a unit's level of organizational ambidexterity can be affected by environmental and organizational antecedents. Jansen et al. (2006) found a Cronbach's Alpha of 0.86.

Other **control variables** include *Gender*, and *Highest Degree*. **Gender** is a dummy variable with Female as Dummy Value. **Highest Degree** is in fact an ordinal variable with 7 categories. We converted these into **one dummy variables** indicating if a respondent's highest degree is a *Master's or Doctor's degree*. 57 responses were collected in one specific firm nicknamed FirmX. Another dummy variable **FirmX** controls for *firm effects*. In addition, we included two continuous variables, *Work Hours* and *Commute Hours*. **Work Hours** (0-70 hours) and **Commute Hours** (0-40 hours) are measured as ratio variables which are answered by means of a slider and measure the overall weekly work hours and the hours of commuting.

Considering Mom et al. (2009) do not retrieve any evidence that exploration and exploitation differ across functional areas as supposed by Duncan (1976), we do not control for functional effects by inclusion of dummy variables. A dummy variables for the firm effects allows to control for differences in organizational contextual factors (Gibson & Birkinshaw, 2004, Mom et al., 2009). We include a dummy variable for one of the three companies where 57 respondents answered. We do not include dummy variables for other firms, considering the limited number of respondents (≤ 11 for each of the two companies).

3.3 Data cleaning: Outliers

One assumption of Multivariate Linear Regression is that there are no outliers.⁸ First we identified separately outliers for Ambidexterity, Job Demands, Job Control and Job Social Support measures. We use the **outlier labelling rule** with 2.2 times the IQR (inter-quartile-range) as cut-off. **Case 2** needs to be deleted when considering Ambidexterity. **Case 63** needs to be deleted when considering Job Control.

In addition, we also consider multivariate outliers. There are two types of outliers: outliers in the response variable that cause model failure and outliers in the predictor variables that are called high leverage points. Three distance measures can be used i.e., Leverage, Mahalanobis, Cook's distance. These statistics indicate how extreme or influential each case is on the MLR. Influential cases are outliers that influence (skew) an analysis in a major way.

Outliers in the predictor variables are sometimes called high **leverage** points. A leverage point-value (h_i) is between 0 and 1. High leverage points, extreme values in the predictors, are cases with $h_i > 3p/n$ (p : number of model terms incl. constant, and n : number of observations). **Mahalanobis distance (MD)** gives the distance between two points in multivariate space. Euclidian distance is appropriate in case of maximum three variables. Mahalanobis distance is, unlike Euclidean distance, still appropriate in case in more than three variables are included as long as variables are not highly correlated (Varmuza & Filzmoser, 2016). Mahalanobis distance allows detection of multivariate outliers (with degrees of freedom equal to # predictor variables in the model, and $\alpha = .001$) based on a chi-square distribution. Whereas MD only uses independent variables in its calculations, **Cook's distance** uses both the independent and dependent variables. Cook's distance (D_i) recalculates the regression without a specific case and summarizes the change of all the values in the regression model. It allows

⁸ The full sample is used in the results section. Afterwards the findings were confirmed when excluding outliers.

to identify, in a set of predictor variables, influential outliers that negatively affect the regression model. Different rules to indicate multivariate outliers exist: larger than 3 times the mean ($3 \cdot \mu$), $4/n$ (n : number of observations), D_i value of more than 1. We prefer the most widely used $4/n$ (n : number of observations).

We consider cases/values as influential multivariate outliers if these are pinpointed by **Mahalanobis distance**. For each detected outlier, we verify simultaneously the two other multivariate outlier detection rules for the respective distance.

In case we included all independent and control variables, we found three cases with a too large MD (case 93/101/49). It indicates an unlikely combination of two or more variables, so these cases were considered as a multivariate outlier. Nevertheless, outlier detection can be incomplete in case of multiple outliers due to a masking effect whereby one outlier masks the appearance of another one (Rousseeuw & Van Zomeren, 1990). Therefore we rerun the test after we deleted the first set of outliers and we find an additional outlier (case 24). After exclusion of this outlier, no other multivariate outliers could be detected. Eventually, four influential multivariate outliers were identified (cases 93/101/49/24)⁹. We do the analysis once with cases 2/63/93/101/49/24 ($n=183$), and once without these¹⁰.

4. Results

4.1 Descriptive statistics:

We asked for diverse **descriptive statistics**: *Sector, Average project duration, Number of projects, Reimbursement of overtime, Gender, Highest Degree, Age, and Job experience (tenure within the sector)*. An overview is given in Table 13. **Sector** is a categorical variable with ten categories. The 183 respondents belong mainly to IT (consultancy) (39.3%), Legal services (15.8%), and Engineering/Construction (15.3%). Other sectors are less often represented, as shown in Table 13. **Average project duration** is an ordinal variable with 7 categories. There is quite some variance in project duration: ranging from 1 week (3.3%) to more than 1 year (33.9%).

Number of projects is again an ordinal variable with 7 categories. Most respondents work on multiple project at the same time: only 13.1% work on one project at the same time, whereas 37,2% work on 2-3 projects simultaneously and 24.6% even on 4-6 projects. In terms of **Reimbursement of overtime**, only 30 (17.0%) got their overtime paid, and 146 respondents (83.0%) indicated overtime was not paid. In the sample, 71.3% of the respondents were male and 28.7% were female. For educational background, the results show that 78.2% have a Master's Degree and 16,9% a Bachelor's degree. Age shows diverse answer patterns: respondents have various ages. Mom et al. (2009) were aware of the association between an individual's experience and the ability to interpret and deal with a larger diversity of ambiguous cues (Daft & Lengel, 1986, p. 555). Mom et al. (2009) hence included **age** and **tenure within the firm** to control for a manager's experience. They did find a significant positive association between both control variables and ambidexterity in line with Tushman, and O'Reilly (1996, p. 27) their expectations. Furthermore, Mom et al. (2009) found considerable and significant effects of "**tenure in current position**" with regard to managers' ambidexterity. We only consider one **categorical variable** for **tenure within the sector** as single variable instead of consideration of both

⁹ The MD deletes all multivariate outliers that would be detected using the **leverage**-method. If we, in addition to these four outliers, also use the more strict **Cook's distance** then also the cases 110, 109, 60, 47, 34, 80, 40, 55, 8, and 98 need to be deleted.

¹⁰ Conclusions remain with $n=177$ and $n=167$.

tenure within the firm or position. The 183 respondents demonstrate that a wide variety in experience within the sector, with 36% of respondents having an experience ranging between 2 and 5 years.

Table 13 shows quite some dispersion for all variables that are included in the regression analysis and already allows some interesting findings. The average **Job Fatigue** among the 183 respondents in the sample is 3.6279 (sd. 1.08903) on a 7-point Likert scale. **Exploitation** has a mean of 4.1366 (sd. .86082) while **Exploration** has a mean of 4.3544 (sd. 1.08454). **Ambidexterity**, measured as the sum of **Exploitation** and **Exploration**, had a mean of 8.491 (sd. 1.35449). **The construct measures to what extent a respondent has been doing certain project activities related to exploitation or exploration in the past six months.** Scores on items vary from 1 (to a very small extent) to 7 (to a very large extent). An average score for both Exploitation and Exploration between 4 (neutral) and 5 (to a rather large extent), is quite high. It means that respondents do spend quite some time on Exploitation and at the same time do spend quite some time on Exploration. There is also a quite high average on Ambidexterity (measured by the sum). Overall we can conclude we have an appropriate sample to investigate Ambidexterity, considering a lot of respondents do combine Exploitation and Exploration. Table 14 illustrates that 64 % of the respondents report scores on Exploitation that average from a neutral to large extent (≥ 4) whereas 66 % of the respondents report scores on Exploration from a neutral to large extent (≥ 4). 42 % of the respondents indicated they combined both Exploitation (≥ 4) and Exploration (≥ 4) from a neutral to large extent (≥ 4).

The mean values for **Job Demands** (mean: 4.3813 /sd.: .97635), **Job Control** (mean: 5.0949/sd.: .88565), and **Job Social Support** (mean: 4.9454/sd.: 1.27034) are again quite high. Both Ambidexterity-values and Job Demands-, Job Control-, and Job Social Support-values are mean-centered to calculate the interaction term. A mean of 4.7582 (sd.: 1.24557) for **Environmental Dynamism**, and a mean of 5.3429 (sd.: 1.11075) for **Environmental Competitiveness** illustrate that the environment the respondents work in are on average quite dynamic and competitive. An average **Job Intrinsic Motivation** of 5.7996 (sd.: .82612) indicates that most respondent agree with statements expressing their joy for exploration. On average the respondents report 48.0820 (sd.: 8.54522) **Work Hours** a week and 8.1202 (sd.: 5.77288) **Commute Hours**.

4.2 Correlation matrix

Table 15 shows varying levels of Pearson's correlation between 11 constructs included in the model.

When considering the dependent variable, we do not observe a correlation of Job Fatigue with Exploitation, nor Exploration, nor Ambidexterity as the sum of Exploitation and Exploration. We do find a correlation of Job Fatigue with Job Demands (+), Job Control (-), and Job Social Support (-). This is in line with Van Yperen, and Hagedoorn (2003) who found strong associations between Job Fatigue and Job Demands ($r = 0.43$) and Job Fatigue and Job Control ($r = -0.32$). Job Fatigue seems also correlated to Job Intrinsic Motivation (-), Work Hours (+), and a Master or dr.-degree (+).

We do not find a significant correlation between Exploitation and Exploration. Ambidexterity is obviously correlated with Exploitation (+), and Exploration (+). Furthermore, Ambidexterity is correlated with Job Demands (+), Environmental Dynamism (+), Job Intrinsic Motivation (+), and Work Hours (+). Whereas Exploitation is correlated with Job Demands (+), Environmental Competitiveness (+), and Master or dr.-degree (-), Exploration is correlated with Environmental Dynamism (+), and Job Intrinsic Motivation (+).

With regard to the independent and control variables, we find 3 couples of variables that have correlations less than $-.32$ or greater than $.32$. Van Yperen, and Hagedoorn (2003) observed strong associations between Job Control and Job Demands ($r = -0.34$). We do not find a significant correlation between Job Demands and Job Control, but do find a significant correlation between Job Demands and Job Social Support ($-.330$). There is also a significant positive correlation between Job Demands and Work Hours ($.334$). Environmental Dynamism and Environmental Competitiveness do have a very high correlation (0.441) as well. Nevertheless, this just illustrates the focus on competitive and dynamic project business contexts. As a result, the high correlation is considered acceptable.

4.3 Hypothesis testing

Linear regression analysis implies assumptions of normality, linearity, homoscedasticity, and absence of multicollinearity, that all need to be tested. The **unstandardized residuals** of the multiple regression do follow a **normal** distribution according to both the normal QQ-plot and a Shapiro-Wilk test for normality. When plotting the **predicted values** and **residuals** on a scatterplot, we also found that residuals are equally distributed and thus data is **homoscedastic**. Considering residuals are normally distributed and homoscedastic, we do not have to verify if predictor variables in the regression have a linear relationship with the outcome variable. **Multicollinearity** is no problem as well (all **VIF** < 2). The multiple predictor variables included in the multiple linear regression, are not highly correlated. As shown above in the correlation matrix, no coefficients approach or exceed $.80$ and all are even below $.5$.

Results for all complete surveys ($n=183$), are documented in Table 16. Results excluding the outliers ($n=177$) are reported in Table 17.

In Table 16 we see that all models are significant. The initial model (F-value 3.824^{**}), with only the control variables, has an R^2 of $.150$. Inclusion of Ambidexterity, results in an increase in R^2 from $.150$ to $.167$. Inclusion of Job Demands, Job Control, and Job Social Support as well as their interaction terms with Ambidexterity, results in an increase in R^2 from $.167$ to $.439$. This final model is highly significant (F-value 8.722^{**}).

A weakly significant ($\alpha = .10$) effect could be found for Ambidexterity on Job Fatigue ($\beta = .122$, $p = .077$). Nevertheless, it is hypothesized that Ambidexterity has a positive effect on Job Fatigue, and one-sided ($\beta = .122$, $p = .077/2$) we do find a significant effect. We find support for **hypothesis 1**. We conclude that individuals **level of ambidexterity** is **positively/unfavorably** correlated with **Job Fatigue**.

As expected, Job Fatigue (see Table 16) is positively affected by Job Demands ($\beta = .365$, $p = .000$) and negatively by Job Control ($\beta = -.284$, $p = .000$) and Job Social Support ($\beta = -.165$, $p = .010$). We find support for **hypothesis 2**, **hypothesis 3**, and **hypothesis 4**. We can conclude for individuals in project organizations striving for ambidexterity; (H2) **Job Demands** has a **positive/unfavorable** impact on **Job Fatigue**, (H3) **Job Control** has a **negative/favorable** impact on **Job Fatigue**, and (H4) **Job Social Support** has a **negative/favorable** impact on **Job Fatigue**.

We do not find a significant (interaction) effect for Ambidexterity and Job Demands, nor for Ambidexterity and Job Social Support. We find no support for **hypothesis 5** that the **positive/unfavorable** impact of **Job Demands** on **Job Fatigue**, is **reinforced** when **Ambidexterity** is high, neither do we find support for **hypothesis 7** that the **negative/favorable** impact of **Job Social Support** on **Job Fatigue**, is **reinforced** when ambidexterity is high.

We do find one significant interaction effect for Ambidexterity and Job Control on Job Fatigue ($\beta = .208$, $p = .001$). Considering we do find support for **hypothesis 6**, we conclude that the **negative/favorable** impact of **Job Control** on **Job Fatigue**, is **reduced** when ambidexterity is high.

Significant control variables in the final model are Environmental Competitiveness ($\beta = -.132$, $p = .048$), Job Intrinsic Motivation ($\beta = -.170$, $p = .007$), and Work Hours ($\beta = .171$, $p = .013$).

With a significance of $\alpha = .05$ (one-tailed), we find evidence that individuals their **striving for ambidexterity** is **positively/unfavorably** correlated with **Job Fatigue** (supporting H1). With a significance of $\alpha = .01$, we find evidence that **Job Demands** are **positively/unfavorably** correlated with **Job Fatigue** (supporting H2), **Job Control** is **negatively/favorably** correlated with **Job Fatigue** (supporting H3), and **Job Social Support** is **negatively/favorably** correlated with **Job Fatigue** (supporting H4). We do not find evidence that supports that the **positive/unfavorable** impact of **Job Demands** on **Job Fatigue**, is **reinforced** when **Ambidexterity** is high (no support for H5), nor that the **negative/favorable** impact of **Job Social Support** on **Job Fatigue**, is **reinforced** when ambidexterity is high (no support for H7). We find a positive interaction effect of Ambidexterity Activities and Job Control on Job Fatigue. With a significance of $\alpha = .01$, we find evidence that the **negative/favorable** impact of **Job Control** on **Job Fatigue**, is **reduced** when ambidexterity is high (H6).

4.4 Robustness tests

When the regression ($n=183$) was done using the **full constructs**, so without leaving out the reversed items, and item 1 and 3 of exploitation, the findings were confirmed. Slight differences in significance appear. The final model is highly significant (F-value 8.500**) and has an R^2 of .433. A weakly significant ($\alpha = .10$) effect could be found for Ambidexterity on Job Fatigue ($\beta = .132$, $p = .054$, two-sided). Nevertheless, it is hypothesized that Ambidexterity has a positive effect on Job Fatigue, and one-sided we do find a significant effect at $\alpha = .05$. It means H1 is accepted with a significance of $p = 0.054/2$. Again Job Fatigue is positively affected by Job Demands ($\beta = .350$, $p = .000$, two-sided) and negatively by Job Control ($\beta = -.295$, $p = .000$ two-sided) and Job Social Support ($\beta = -.165$, $p = .010$ two-sided). The positive interaction effect for Ambidexterity and Job Control on Job Fatigue ($\beta = .185$, $p = .004$) remains. Also the effect of Job Intrinsic Motivation ($\beta = -.179$, $p = .006$) and Work Hours ($\beta = .159$, $p = .022$) on Job Fatigue remain significant. The effect of Environmental Competitiveness ($\beta = -.125$, $p = .063$) loses its significance (two-tailed). In sum, the evidence for H1, H2, H3, H4, and H6 is confirmed again.

The findings are confirmed when excluding 6 influential outliers using the **outlier labelling rule** (2 cases) and **Mahalanobis Distance** (4 cases). Slight differences in significance appear. However, the final model ($n=177$) is still highly significant (F-value 7.853**) and has an R^2 of .423. A significant ($\alpha = .05$) effect could be found for Ambidexterity on Job Fatigue ($\beta = .145$, $p = .038$, two-sided). It means H1 is accepted with a significance of $p = 0.038/2$. Again Job Fatigue is positively affected by Job Demands ($\beta = .342$, $p = .000$ two-sided) and negatively by Job Control ($\beta = -.282$, $p = .000$ two-sided) and Job Social Support ($\beta = -.214$, $p = .001$ two-sided). The positive interaction effect for Ambidexterity and Job Control on Job Fatigue ($\beta = .159$, $p = .012$) remains. Also the effect of Job Intrinsic Motivation on Job Fatigue ($\beta = -.150$, $p = .023$) remains significant. The effects of Environmental Competitiveness ($\beta = -.131$, $p = .063$), and Work Hours ($\beta = .129$, $p = .060$) lose their significance (two-tailed). In sum, the evidence for H1, H2, H3, H4, and H6 is confirmed again.

The findings are also confirmed when excluding 16 influential outliers using the outlier labelling rule (2 cases), Mahalanobis Distance (4 cases), as well as **Cook's distance** (10 cases). Slight differences in

significance appear, and again the final model ($n=167$) is highly significant (F-value 9.495**) and has an R^2 of .485. A significant ($\alpha = .05$) effect could be found for Ambidexterity on Job Fatigue ($\beta = .134$, $p = .049$, two-sided). It means H1 is accepted with a significance of $p = 0.049/2$. Again Job Fatigue is positively affected by Job Demands ($\beta = .409$, $p = .000$ two-sided) and negatively by Job Control ($\beta = -.266$, $p = .000$ two-sided) and Job Social Support ($\beta = -.197$, $p = .003$ two-sided). The positive interaction effect for Ambidexterity and Job Control on Job Fatigue ($\beta = .113$, $p = .068$, two-sided) loses some significance. Nevertheless, it is hypothesized that Ambidexterity and Job Control have a positive/unfavorable interaction effect on Job Fatigue, and one-sided we do find a significant effect at $\alpha = .05$. It means H6 can be accepted with a significance of $p = 0.068/2$. Also the effect of Job Intrinsic Motivation on Job Fatigue ($\beta = -.170$, $p = .009$) remains significant. The effect of Environmental Competitiveness ($\beta = -.070$, $p = .310$) loses its significance. The effect of Work Hours ($\beta = .127$, $p = .063$, two-sided) loses some significance, but stays significant when using the appropriate one-sided test. In sum, the evidence for H1, H2, H3, H4, and H6 is confirmed again.

In another regression analysis ($n=183$), a dummy variables controlled for the effects of different data collection methods. Almost all data batches were collected by mailings. Only batch 1 was collected by a LinkedIn-post by one of the researchers. When including an additional **dummy variable** that controlled for the data collected by means of **LinkedIn** ($n=183$), all results remained and the dummy variable is not significant ($p = .393$, two-sided). Slight differences in significance appear, and again the final model is highly significant (F-value 8.209**) and has an R^2 of .442. A weakly significant ($\alpha = .10$) effect could be found for Ambidexterity on Job Fatigue ($\beta = .127$, $p = .067$). Nevertheless, it is hypothesized that Ambidexterity has a positive effect on Job Fatigue, and one-sided ($\beta = .127$, $p = .067/2$) we do find a significant effect. As expected, Job Fatigue is positively affected by Job Demands ($\beta = .361$, $p = .000$, two-sided) and negatively by Job Control ($\beta = -.297$, $p = .000$, two-sided) and Job Social Support ($\beta = -.162$, $p = .012$, two-sided). We do find one significant interaction effect for Ambidexterity and Job Control on Job Fatigue ($\beta = .213$, $p = .001$, two-sided). Significant control variables in the final model are Environmental Competitiveness ($\beta = -.145$, $p = .034$, two-sided), Job Intrinsic Motivation ($\beta = -.166$, $p = .009$, two-sided), and Work Hours ($\beta = .164$, $p = .018$, two-sided). In sum, the evidence for H1, H2, H3, H4, and H6 is confirmed again.

Despite the sum of exploitation and exploration is a more appropriate construct to measure ambidexterity when relying on conflicting goals theory, a regression analysis with the **multiplication of exploitation and exploration** was done as robustness test. Both the main effect of ambidexterity, as well as the interaction effects with Job Demands, Job Control, and Job Social Support are done again.

The final model ($n=183$) is highly significant (F-value 7.487**) and has an R^2 of .402. No significant effect could be found for Ambidexterity on Job Fatigue ($\beta = .062$, $p = .381$, two-sided). Nevertheless, it is hypothesized that Ambidexterity has a positive effect on Job Fatigue, and one-sided ($\beta = .127$, $p = .067/2$) we do find a significant effect. As expected, Job Fatigue is positively affected by Job Demands ($\beta = .344$, $p = .000$, two-sided) and negatively by Job Control ($\beta = -.229$, $p = .001$, two-sided) and Job Social Support ($\beta = -.154$, $p = .021$, two-sided). We do not find significant interaction effects for Ambidexterity and Job Demands, Job Control, or Job Social Support. So only H2, H3, and H4 are retrieved when using the multiplication of exploitation and exploration instead of the sum.

There is no correlation between Exploitation and Exploration. In an additional analysis, **Exploitation** and **Exploration** are included **separately**. Both the main effect of Exploitation and Exploration, as well as their respective interaction effects with Job Demands, Job Control, and Job Social Support are included.

The final model ($n=183$) is highly significant (F-value 6.952**) and has an R^2 of .448. No significant effect could be found for Exploitation on Job Fatigue ($\beta = .076$, $p = .248$, two-sided). A weakly significant ($\alpha = .10$) effect could be found for Exploration on Job Fatigue ($\beta = .118$, $p = .088$, two-sided). Nevertheless, one-sided the effect of Exploration on Job Fatigue would be significant at $\alpha = .05$ with a significance of $p = 0.088/2$. Again Job Fatigue is positively affected by Job Demands ($\beta = .356$, $p = .000$, two-sided) and negatively by Job Control ($\beta = -.274$, $p = .000$, two-sided) and Job Social Support ($\beta = -.158$, $p = .021$, two-sided). We do not find significant interaction effects for Exploitation and Job Demands, Job Control, or Job Social Support. Nevertheless, two effects would approach significance if tested one-sided: the interaction effects of Exploitation and Job Demands ($\beta = -.106$, $p = .124$, two-sided), as well as Exploitation and Job Control ($\beta = .101$, $p = .113$, two-sided). Both interaction effects of Exploration and Job Demands and Exploration and Job Social Support are not significant at all. We do find one significant interaction effect for Exploration and Job Control on Job Fatigue ($\beta = .194$, $p = .003$, two-sided). Significant control variables in the final model are Environmental Competitiveness ($\beta = -.150$, $p = .031$, two-sided), Job Intrinsic Motivation ($\beta = -.185$, $p = .005$, two-sided), and Work Hours ($\beta = .182$, $p = .009$, two-sided). Considering the project businesses in the sample are characterized by quite some competition and dynamism, which is also confirmed by the respondents' answers for Environmental Dynamism and Environmental Competitiveness, most respondents need to demonstrate a high level of Exploitation and Exploration. For that reason, it is appropriate to investigate the impact of combining these conflicting goals on Job Fatigue.

Multicollinearity was no problem in hypothesis testing. Nevertheless, we also added three tests to verify if Ambidexterity, Exploitation, or Exploration can be explained by other variables in the model.

Table 18 demonstrates no multicollinearity problems for Ambidexterity. The final model is highly significant (F-value 4.275**) and has an R^2 of .216. Only three control variables have a significant ($\alpha = .05$, two-sided) effect: Environmental Dynamism ($\beta = .160$, $p = .042$), Job Intrinsic Motivation ($\beta = .301$, $p = .000$), and the FirmX-dummy variable ($\beta = -.216$, $p = .003$). Job Demands ($\beta = .146$, $p = .059$ two-sided) approaches $\alpha = .05$ -significance.

Table 19 neither demonstrates multicollinearity problems for Exploitation. The final model is highly significant (F-value 2.328**) and has an R^2 of .141. Only two control variables have a slightly significant ($\alpha = .05$, two-sided) effect: Environmental Competitiveness ($\beta = .164$, $p = .046$), and the 'Highest Degree: Mast. or Dr.'-dummy variable ($\beta = -.151$, $p = .043$). FirmX-dummy variable ($\beta = -.140$, $p = .072$, two-sided) approaches $\alpha = .05$ -significance. In addition, Job Demands ($\beta = .155$, $p = .056$, two-sided) approaches $\alpha = .05$ -significance.

And finally, Table 20 neither demonstrates multicollinearity problems for Exploration. The final model is highly significant (F-value 3.088**) and has an R^2 of .179. Only three control variables have a significant ($\alpha = .05$, two-sided) effect: Environmental Dynamism ($\beta = .218$, $p = .007$), Job Intrinsic Motivation ($\beta = .323$, $p = .000$), and the FirmX-dummy variable ($\beta = -.189$, $p = .013$).

5. Discussion

The findings allow diverse conclusions (Table 16). Project organizations striving for ambidexterity can require individual coworkers to perform high on both Exploitation and Exploration. A higher level of Ambidexterity has, other things equal, a positive effect on Job Fatigue. Nevertheless, we only notice a very small increase in R^2 of 2%. The inclusion of Job Demands, Job Control, and Job Social Support, and their interaction terms with **Ambidexterity**, result in a much larger increase in R^2 of 27%. Standardized coefficients illustrate that Project Organizations striving for ambidexterity, need to reduce the Job Demands experienced by their personnel of which they expect Ambidexterity. At the same time these companies should raise the experienced Job Social Support at the workplace to lessen Job Fatigue. For Job Control, we found two different significant effects. First, Project Organizations striving for ambidexterity, should raise the Job Control experienced by their personnel of which they expect Ambidexterity. An increase in Job Control can reduce Job Fatigue. Second, a significant **interaction effect** of **Ambidexterity** and **Job Control** illustrates that the negative, favorable effect of Job Control on Job Fatigue is lower in case of a higher level of Ambidexterity. All other things being equal, raising the experienced Job Control thus reduces Job Fatigue more in case of low Ambidexterity than in case of high Ambidexterity. Nevertheless, even coworkers in high ambidexterity contexts can benefit from a higher experienced Job Control in order to reduce Job Fatigue.

Findings are partly in line with literature. Mom et al. (2007) already illustrated by means of a non-significant correlation between exploration and exploitation, and by the results of the exploratory and confirmatory factor analyses, that exploration and exploitation are two distinct latent factors of a second order ambidexterity construct. They found as well that a considerable difference in individual's ambidexterity can exist: some managers engage more in exploration as compared to exploitation, or the other way around, and other managers have high levels of both exploration and exploitation (Mom et al., 2007). Mom et al. (2009) demonstrated that managers can achieve higher levels of ambidexterity at the individual level when they take part in cross-functional interfaces, are connected to other organizational members and have some decision-making authority. These characteristics that explain Ambidexterity, resemble the Job Social Support and Job Control characteristics that are now included in this study about Job Fatigue. The current paper's findings support the proposition that Exploration and Exploitation are two distinct factor that are not mutually exclusive at the individual level. There was again a non-significant correlation between exploration and exploitation, and exploratory and confirmatory factor analyses indicated that exploration and exploitation are two separate dimensions. Despite Exploration and Exploitation are opposing goals, individuals demonstrated high levels of both.

It is known that the goal **conflict effect** on performance is **not mediated** by commitment, goal priority, goal level or strategies and more research is asked to find out what does mediate the effects of goal conflict (Locke et al., 1994). Occupational health literature already found that exhaustion, **job fatigue**, stress etc. have an **unfavorable performance effect**. We found that ambidexterity, operationalized as the sum of conflicting objectives, has an impact on Job Fatigue. So **ambidexterity may be a mediator** between goal conflict and performance. **Future research** should include the direct performance effects of ambidexterity, as well as the indirect effects via **Job Fatigue**.

Earlier research states that striving for ambidexterity is difficult for an individual (Simsek et al., 2009; Gupta et al., 2006). As Simsek et al. (2009) mentioned "*pursuing exploitation and exploration harmoniously within a single organizational unit is inherently challenging, because each competes for scarce resources, leading to **conflicts, contradictions, and inconsistencies.***" (2009). Also Gupta et al. (2006) indicate that substantial differences in routines and focus on learning, may hinder an individual or even subsystem to combine or even switch between routines of exploration and exploitation. Combining both simultaneously would be easier for a group, organization or another larger system

than for individuals. This positive, unfavorable effect of Ambidexterity on Job Fatigue is retrieved in this study. This study finds evidence that Exploitation and Exploration are conflicting goals and the combination of both, ambidexterity, has an unfavorable effect on Job Fatigue.

In addition, we build further on literature that emphasizes the need for an appropriate organizational context and culture when striving for ambidexterity (Burgelman, 1991; Ghoshal & Bartlett, 1994; Gibson & Birkinshaw, 2004; Simsek et al., 2009). *“Such a context involves a joint emphasis on high performance (discipline and stretch) and social support (support and trust)”* to encourage individuals *“to make integrative judgements as to how to best divide their time between the conflicting demands for alignment and adaptability”* (Simsek et al., 2009, p. 881). The need for management that enables individuals when striving for ambidexterity was earlier indicated by Gibson & Birkinshaw (2004, p. 210) who emphasize the need to build *“a set of processes or systems that enable and encourage individuals to make their own judgments about how to divide their time between conflicting demands for [exploitation and exploration]”*. Also Gilson et al. (2005) found that the teams that felt empowered by their organization to rely on both creativity and standardized work practices, had a higher team effectiveness. Whereas this literature focuses on the impact of the context on individuals level of Ambidexterity, we investigated similar characteristics their impact on Job Fatigue. Karasek’s demand-control-support model consists of **Job Demands, Job Control and Job Social Support**. We include Job Demands as a measure for a context with an **emphasis on high performance**, Job Social Support as a measure for the **emphasis on social support**, and Job Control as a measure for an **individual’s ability to decide with regard to both timing as well as method of own activities**.

There are multiple theoretical contributions. One theoretical contribution is that we control for **general characteristics of project management instead** of restricting ourselves to a limited set of specific control practices. Effects of specific management controls can depend on their combination with other management controls. A focus on project management characteristics offers more robust conclusions without this need to consider all other management controls by which effectiveness can be influenced. Like this, focusing on general management characteristics is feasible, whereas it is difficult to capture all relevant specific management controls and their potential relations. Focusing on general management characteristics can help future research to disentangle influences of individual controls within a context. Experiments, for instance, could be used to test the effects of individual controls on the overall desired management characteristics. The study like this offers valuable research approaches for future management control studies. It illustrates a **valuable way to investigate the overall impact of a package as a whole**, and it allows to focus on the **impact of specific management controls within a control package on the overall package characteristic**.

Another contribution to literature concerns the empirical disentanglement of diverse explanations for Job Fatigue in project organizations striving for Ambidexterity. Striving for ambidexterity itself only partially explains variances in Job Fatigue. A far larger amount of variance is explained by Job Demands, Job Control and Job Social Support. For this research, **two not earlier related literature streams were combined: ambidexterity literature** and literature describing **Karasek’s demand-control-support model its impact on job fatigue**. We contribute to these literatures by illustrating that **striving for ambidexterity** explains only a small amount of variance in Job Fatigue. Job Demands, Job Control and Job Social Support explain a much larger part of individuals their Job Fatigue. Higher Job Fatigue is associated with higher Job Demands, lower Job Control and lower Job Social Support. A positive interaction effect of Ambidexterity and Job Control with weakens Job Control its reduction effect on Job Fatigue. However, Job Control is still appropriate to reduce Job Fatigue in case employees need to combine Exploitation and Exploration. In addition, we find a negative effect of Job Intrinsic Motivation on Job Fatigue. Employees put to Ambidexterity in project organizations can be selected based on their

Job Intrinsic Motivation as a mean to limit the average Job Fatigue. The positive, unfavorable effect of Work Hours on Job Fatigue is another logic finding. Less explicable is the negative, favorable effect of Environmental Competitiveness on Job Fatigue. A first possible explanation is that the attribution of pressure to environmental conditions makes individuals accept it better and this acceptance influences Job Fatigue. Another possible explanation is that people who prefer working in competitive businesses experience, on average, less Job Fatigue. Future research should investigate this.

The significant interaction effect of Ambidexterity and Job Control on Job Fatigue can be approached from earlier literature. Chung-Yan (2010) found a nonlinear effect of job complexity and autonomy on job satisfaction, turnover, and psychological well-being. Chung-Yan (2010) their definition of job complexity is somehow similar to contextual ambidexterity. Jobs were one cannot just adhere to standard procedures and existing work methods, but must search for novel approaches and alter work methods, are considered as complex jobs. Job complexity was found to have an unfavorable effect on psychological well-being, and thus to be a stressor, in case job complexity was already high. In a setting with an already high job complexity/ambidexterity, we found as well that ambidexterity had a slightly significant unfavorable effect on Job Fatigue.

The results further demonstrated an interaction effect between job complexity and job autonomy, and curvilinear relationships to the outcome variables. Job complexity is a stressor when job autonomy is low. Chung-Yan (2010, p. 245) concluded “*Overall, the worst outcomes (i.e., low job satisfaction, high turnover intentions, low psychological well-being) occur when job complexity is high and job autonomy is low.*” Job autonomy needs to rise to match the increasing job complexity and offset the negative consequences. One needs to combine job complexity with a high level of job autonomy to achieve the most beneficial effects. Chung-Yan (2010, p. 248) gave a possible practical explanation for this:

“Given the numerous methods and considerations that could possibly go into performing the duties inherent in complex jobs, a greater amount of autonomy must be given to workers engaged in these types of job. If workers were required to seek approval for every action and decision they made, they would be inefficient and may even miss time-sensitive opportunities. They would also feel constrained by the necessity to seek approval and this might negatively impact innovation as employees would seek to accomplish their goals through conventional means in order to avoid delays.”

If we consider Ambidexterity, and thus conflicting goals, as an aspect of job complexity, we find a similar interaction effect as Chung-Yan (2010). For Job Control we find a main effect and an interaction effect. There is a negative, favorable main effect of Job Control on Job Fatigue. We find beneficial effects of Job Control on Job Fatigue, which resemble the beneficial effects of job autonomy on psychological well-being in case of high job complexity. The interaction effect we find shows that the favorable effects of Job Control on Job Fatigue diminishes for higher levels of Ambidexterity. Chung-Yan (2010, p. 245) discussed such interaction effect as well: “*in the presence of very high job complexity, there was a point at which increasing job autonomy did not see a positive impact on the outcomes and the influence of job autonomy plateaued (i.e., the associations with the outcomes were reduced).*” Chung-Yan (2010) found that the favorable effect of job autonomy on well-being plateaued in the presence of very high job complexity. The interaction effect found in this study is similar. Ambidexterity implies high job complexity. A greater amount of job control then gives workers autonomy to efficiently accomplish their goals. Greater job control, and thus less constraints, is found to have a negative, favorable effect on job fatigue. Nevertheless, this favorable effect is lower for higher levels of ambidexterity. Probably individual workers that need to combine numerous methods and considerations reach some point where they would like to get more guidance by means of conventional means or approval procedures. The effect of more job control, autonomy, on job fatigue

is thus reduced by increasing levels of Ambidexterity. However, again in line with Chung-Yan (2010), we found that high autonomy is still better than low autonomy in case of high ambidexterity.

Findings can be summarized as follows. We do find evidence that Ambidexterity leads to Job Fatigue. Nevertheless, Karasek's Demand-Control-Support model explains much more variance in Job Fatigue. The findings have **practical relevance** for project organizations that want to limit Job Fatigue while striving for ambidexterity. The study makes it possible for them to focus on the desired project management characteristics instead of trying to disentangle effects of single controls. Higher Job Demands are associated with higher Job Fatigue whereas more Job Control or more Job Social Support reduce Job Fatigue. The higher the coworkers' Ambidexterity, the lower the reduction effect of Job Control on Job Fatigue. In addition, a higher perceived Environmental Competitiveness and more Job Intrinsic Motivation are negatively related to Job Fatigue. Raising the impression of Environmental Competitiveness among project coworkers can possibly reduce Job Fatigue. It would mean that communication to project coworkers about the high competitiveness in the sector can lead to lower Job Fatigue. Furthermore, selection based on Job intrinsic Motivation can be applied. Limiting the number of worked hours is another means to reduce Job Fatigue.

6. Conclusion

The research hypotheses in this paper concern the effect of (1) Ambidexterity, (2) Job Demands, (3) Job Control, and (4) Job Social Support on Job Fatigue. Furthermore, we test the interaction effects between (5) Ambidexterity and Job Demands, (6) Ambidexterity and Job Control, and (7) Ambidexterity and Job Social Support, on Job Fatigue. The research objective is to verify what triggers job fatigue at the individual level. A (1) first hypothesis was that Ambidexterity at the individual level has a positive effect (+) on the individual's Job Fatigue. Furthermore we rely on Karasek's Demand-Control-Support model to hypothesize that (2) Job Demands (+), (3) Job Control (-), and (4) Job Social Support (-) have an effect on Job Fatigue as well. In sum, we hypothesize that Ambidexterity and Job Demands have a positive, unfavorable effect on Job Fatigue whereas Job Control and Job Social Support have a negative, favorable effect on Job Fatigue. For the hypotheses of the interaction effects, we expected that the positive, unfavorable effect of Job Demands on Job Fatigue is reinforced in case of higher Ambidexterity, that the negative, favorable effect of Job Control on Job Fatigue is reduced in case of higher Ambidexterity, and that the negative, favorable effect of Job Social Support on Job Fatigue is reinforced in case of higher Ambidexterity. We further verify if Job Fatigue can also be explained by its project context by consideration of Environmental Dynamism and Environmental Competitiveness. We also control for some individual characteristics: Job Intrinsic Motivation, Work Hours, Commute Hours, Gender, and Highest Degree.

We conclude (Table 16) that an individual's level of ambidexterity is positively, unfavorably related to Job Fatigue. Nevertheless, this striving for ambidexterity does not explain much variance in Job Fatigue. Job Fatigue was, as in theory, related with Job Demands (+), Job Control (-) and Job Social Support (-). In addition, it was related to Environmental Competitiveness (-), Job Intrinsic Motivation (-) and Work Hours (+). The data like this does support that an individual's level of ambidexterity is linked with increased Job Fatigue (H1). Also Job Demands had a positive effect on Job Fatigue (H2). However, Job Control (H3) and Job Social Support (H4) can be used to reduce Job Fatigue. There is only a positive interaction effect of Ambidexterity and Job Control on Job Fatigue (H6). It implies that the higher the level of Ambidexterity, the lower the reduction effect of Job Control on Job Fatigue. These findings are relevant for business. Managers who are aware of the necessary project management characteristics that explain variances in Job Fatigue, can try to manage Job Fatigue among project workers.

We do survey research in practice. The real world is really complex, so we needed to make some simplifications. Hereafter we discuss the (1) **disadvantages of self-reported measures**, (2) possible **self-selection bias**, (3) correlation vs. **causality** and the use of **ordinal Likert scales as interval scales**, (4) the use of Job Fatigue instead of e.g. a measure for burnout, (5) the **time horizon of 6 months** used in the questionnaire, and (6) the assumptions with regard to **linearity**. We find some significant effects with the right direction despite these shortages / imperfections. We are also aware that not finding significant effects does not allow to reject a theory/hypothesis considering these shortages/imperfections.

(1) Self-reported measures can be a limitation when subjective assessments would deviate from objective values. An important remark concerns common method variance and multicollinearity.

Wall et al. (1996) and Van Yperen, and Hagedoorn (2003) noticed that measures such as Job Demands include some affective components (e.g., “Do you have too much work”) which are somehow similar to some fatigue-components. It is possible there is a similar affective component included in measures for Exploration or Exploitation. Nevertheless, both Van Yperen, and Snijders (2000) and Van Yperen, and Hagedoorn (2003) preferred self-report measures because their ability to detect individual variance. *“Self-report measures ignore the shared variance of incumbents, producing overestimations of stressor-strain relationships, whereas “objective” measures and ratings by nonincumbents ignore individual variance, which leads to underestimation of these relationships.”* (Van Yperen & Hagedoorn, 2003, p. 344). We do not expect overestimation of results. We test the construct validity by means of exploratory factor analysis and find a good convergent and discriminant validity of the self-reported measures Job Fatigue, Exploitation, Exploration, Job Demands, Job Control, Job Social Support, Environmental Dynamism, Environmental Competitiveness and Job Intrinsic Motivation.

The use of self-reported measures as Job Fatigue as dependent variable as well as the use of self-reported measures or perceptions for control and independent variables, **makes it possible that common method bias occurs**. Wall et al. (1996) have shown that a higher common method bias reduces the likelihood of detection of interaction effects in the data. We do find one highly significant interaction effect. Furthermore, we do investigate the impact of striving for ambidexterity on Job Fatigue at the individual level. This implies we do need to capture both at the individual level. We measure Exploitation and Exploration by means of Exploration and Exploitation Activities reported by the individuals, just as Mom. et al. (2009), which is a well-considered choice. Achieved levels of Exploration and Exploitation are not objectively quantifiable in this study that focuses on the individual level. Nevertheless, an individual his/her contributions to eventual Exploration or Exploitation is influenced by his/her respective explorative or exploitative activities. Ceteris paribus, individuals who never engage in explorative activities will probably achieve a lower level of exploration than if they would engage. A survey measuring the efforts for Exploration and Exploitation, measures an individual’s striving for ambidexterity. Furthermore, the same objective circumstances can result in different feelings of Job Demands, Job Control, and Job Social Support amongst individuals. Questioning which objective factors impact these three characteristics, would be another research topic which is not in the scope of this paper. This paper clarifies how the Job Demands, Job Control, and Job Social Support experienced by individuals, and their level of Ambidexterity, have an impact on their Job Fatigue. It is a cross-respondent comparative study where the intent of the study is to treat cognitive structures and efforts for Ambidexterity on Job Fatigue, so we do consider the use of same-source respondents and the reliance on same-source correlation as appropriate. Survey measures can clarify these relationships and are thus appropriate. Environmental Dynamism and Environmental Competitiveness can be influenced by an individual’s perception. Nevertheless, findings would remain valuable considering it would imply that differences in perceptions have an impact. Management could

than actively try to adjust individuals their perception about the business context. Overall, we consider the survey measures to have a good face validity and a limited risk of common method variance. A very good construct validity was detected: both convergent and discriminant validity were good. Furthermore, we use large-scale research involving multiple firms with potential firm-based differences in response bias considering the different company cultures. No significant company fixed effect were found in case of FirmX. The significance of effects, despite the inclusion of different firms, illustrates the robustness of the findings. And last but not least, the used set-up avoids ethical problems considering an anonymous data collection was possible.

(2) Self-selection bias is a possible flaw. Respondents were reached via the linked-in profile of one of the researchers, via a newsletter for lawyers, and via three internal company mailings. The links were open for 3 weeks. However, we do not know when the respondents have seen the post on LinkedIn, not all lawyers belong to the same court and receive the newsletter at the same time, and the responses on the internal company mailings were quite clustered after the direct mailing. Comparing late and early responses, cannot be used as a reliable check for self-selection bias. We have not collected much data on individual characteristics to comply with privacy legislation, nor do we have info about company's staff. So again we cannot compare respondents' individual characteristics with company populations. What we do know is that only a part of the lawyers, and a part of the companies' employees, have answered. The response rate was not higher than one fourth to one third. There is a potential self-selection bias, if actual respondents do differ from the group that has not answered. Nevertheless, we do find results despite we use data from several different sources and company settings. This makes the findings quite robust for context-specific self-selection bias. Future research that relies, for instance, on experiments, would allow conclusions that are less susceptible to the risks of self-selection bias.

(3) We do not test **causality**, considering the set-up does not allow to verify the directions. In fact we only proof correlation. We are also aware of possible **endogeneity**. Findings can be influenced by **simultaneity**, **omitted variables** or **measurement error**. Explanatory and dependent variables may be determined jointly and can influence each other. Nevertheless, we assume mainly a one-way-effect based on theory. Furthermore, findings would stay relevant in case of simultaneity. Unobserved or omitted variables can confound both independent and dependent variables. We read through literature and included relevant control variables. In addition, we also found our results robust after including control variables. Future research could include additional control variables. We have not distinguished, for example, between hierarchical levels despite earlier literature demonstrated its relevance with regard to Ambidexterity. Gibson, and Birkinshaw (2004) indicate that ambidextrous individuals need general skills instead of mere specialist skills. In line with Gibson, and Birkinshaw (2004) their expectations, Mom et al. (2009) find that increasing specialization is negatively related to an individual's ambidexterity and they find a strong positive correlation between **hierarchical level** and managers' ambidexterity. Whereas Mom et al. (2009) distinguish business unit level managers and operational level managers, we would propose to distinguish project coworkers and project managers, for instance, by inclusion of a dummy variable "leadership tasks" for project managers. Another issue could be measurement error which concerns differences between a measured quantity and its true value. We use 7-point Likert scales that allow respondents more choice to specify responses than in case of dichotomous or 5-point Likert scales. The 7-point Likert scales sometimes only approximate the strict equality in distance between the attributes and are "in between" ordinal and interval. We include these ordinal variables in quantitative regression analysis and we consider them as interval variables. Here for we assume for all variables that the intervals are equally spaced in order to be able to use statistics that assume the variable is an interval variable. The way of measuring can cause some measurement error. Nevertheless, we do find significant results despite these inaccurate measures.

Improvement of measures could further improve the results found in this study. Future research could also use SEM theory, with Simultaneous Equations Models or Structural Models, which is specifically set up to deal with regression models where endogeneity can occur.

(4) Ethical and privacy restrictions make it very difficult to rely on more weighty mental health measures such as burn-out measures. Nevertheless, we do think **Job Fatigue** is appropriate for this study because it is **measuring one of the central aspects of burn-outs**. *“Burnout is a prolonged response to chronic emotional and interpersonal stressors on the job, and is defined by the three dimensions of exhaustion, cynicism, and inefficacy.”* (Maslach, Schaufeli, Leiter, 2001, p. 397) Exhaustion was often used instead of Job Fatigue in literature. At the same time *“Exhaustion is the central quality of burnout and the most obvious manifestation of this complex syndrome.”* (Maslach et al., 2001, p. 402) Exhaustion reflects the stress dimension of burnout, but is only one of the three aspects of burnout. The other two are cynicism and inefficacy. Cynicism means that people create more emotional and cognitive distance from their work, as a way to cope with the work overload by means of depersonalization (Maslach et al., 2001, p. 403). Inefficacy is often a function of exhaustion, cynicism, or both: one’s sense of accomplishment and effectiveness gets eroded because of chronic, overwhelming demands that contribute to exhaustion or cynicism (Maslach et al., 2001, p. 403). Whereas exhaustion, and cynicism are mostly related to the presence of work overload and social conflict, the lack of efficacy mostly arises from a lack of relevant resources (Maslach et al., 2001, p. 403). The questionnaire takes a **time horizon** of 6 months. Individuals that indicate they faced on average a high level of Job Fatigue during the last 6 months, do probably face a permanent exposure. Nevertheless, it is possible that some individuals have very heavy periods, with high Job Fatigue, with calm periods, with low Job Fatigue. Considering the targeted project businesses, and the high average work hours, a permanent exposure is expected. However, to the extent that there is a change in intensity, results can be biased considering measures rely on averages.

(5) The **time horizon** of 6 months is also used for other constructs in the questionnaire. It is, for instance, possible that respondents work on average half time on projects that require exploration and half time on project that require exploitation. Again this is not likely considering the targeted project businesses mostly require a combination of exploitation and exploration at the same time. The high reported levels for both Exploration and Exploitation further affirm that respondents must do quite some Exploration and Exploitation simultaneously.

(6) We use linear regression which assumes linear relations. We are conscious about possible non-linearity in this specific setting as well. Earlier research has demonstrated some curvilinear relations, e.g. there would be different effects of the Job Demand-Control-Support model between low demand and high demand contexts. Considering the limited focus on project business with a need for ambidexterity, we do not include such interaction effects. We assume linear relations considering we focus on high demand project contexts (considerable contextual dynamism and competitiveness) with a need to strive for exploration and exploitation. Nevertheless, in case the underlying relations are e.g. curvilinear instead of linear, findings would underestimate the real relations considering curvilinear relations are retrieved when testing for linearity. Future research could consider non-linear relations between variables and could find even stronger effects or even more significant effects when doing so.

Some findings could not be retrieved. This is no proof that the expected relations do not exist. We follow the open world assumption of in Reiter (1980, 1981). We made hypotheses about reality. In a closed world, there are only two possibilities. (1) The effects can be true if these are significant and have the right sign. Or (2) the effects can be false if these are significant and have the wrong sign. In

an open world, there is a third possibility. (3) The effects can be unknown if these are not significant which can, for instance, be due to the way of measuring (no normality, omission of variables etc.).

We have several other recommendations for future research as well. It can use other constructs for exploration and exploitation. It can, for instance, try to find objective measures instead of self-reported measures. Other control variables can be included to prevent confounding variables. In particular, we also suggest the inclusion of individual characteristics such as knowledge, skills, psychical fitness and mental strength considering earlier research indicates that unhappy and highly stressed employees could limit and focus their efforts on Exploitation. Future research could also consider other emotions instead of Job Fatigue. We further recommend other research methods such as experiments. It can allow to use objective measures or randomize treatments at the sample selection stage in a way to level out effects of possible third variables. It can also allow to test causality.

7. References

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8. Appendix

Figure 9 : Research model

(H1) Ambidexterity

- Exploitation
- Exploration

Project management characteristics

- (H2) Job Demands
- (H3) Job Control
- (H4) Job Social Support

Interaction effects

- (H5) Job Demands x Ambidexterity
- (H6) Job Control x Ambidexterity
- (H7) Job Social Support x Ambidexterity

Control variables

Business context

characteristics

- Environmental Dynamisms
- Environmental Competitiveness

Individual characteristics

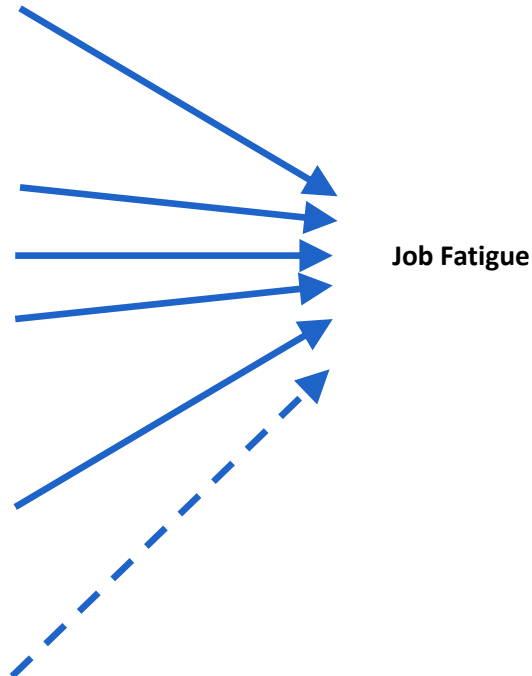
- Job Intrinsic Motivation

Other individual characteristics

- Work Hours
- Commute Hours
- Gender
- Highest Degree

Firm effects

- Dummy Fixed Firm Effects



Descriptives:

Sector, Average project duration, Number of projects, Reimbursement of overtime, Gender, Highest Degree, Age, and Job experience (tenure within the sector)

Table 12 : Rotated Component Matrix: Independent variables + Job Fatigue

	9 factors (Direct Oblimin)	9 factors (Varimax)
Job Fatigue	$\alpha = 0.907$	$\alpha = 0.907$
(1) In general, I feel rather fit after dinner. (Reversed)	X	X
(2) I find it difficult to relax at the end of a working day.	.623	.664
(3) At the end of a working day, I feel really fatigued.	.534	.559
(4) Due to my job, I feel rather exhausted at the end of a working day.	.727	.733
(5) I usually do not calm down until my second day off.	.672	.668
(6) After work, it takes effort to concentrate in my spare time.	.719	.720
(7) When I just come home, I have little interest in other people.	.663	.671
(8) In general, it takes me more than an hour to recover completely after work.	.820	.810
(9) When I come home, they must leave me alone for a while.	.745	.728
(10) After a working day, I frequently feel too fatigued to engage in any other activity.	.860	.822
(11) During the last stage of a working day, I often feel too fatigued to perform well.	.664	.664
Exploitation	$\alpha = 0.670$	$\alpha = 0.670$
(1) Activities of which a lot of experience has been accumulated by yourself	X	X
(2) Activities which you carry out as if it were routine	.588	.585
(3) Activities which serve existing customers with existing services/products	X	X
(4) Activities of which it is clear to you how to conduct them	.794	.796
(5) Activities primarily focused on achieving short-term goals	.466	.464
(6) Activities which you can properly conduct by using your present knowledge	.724	.715
(7) Activities that are clearly prescribed by existing policies, procedures or other guidelines	.576	.585
Exploration	$\alpha = 0.821$	$\alpha = 0.821$
(1) Searching for new possibilities with respect to products/services, processes or markets	.752	.756
(2) Evaluating diverse options with respect to products/services, processes or markets	.706	.709
(3) Focusing on strong renewal of products/services or processes	.748	.751
(4) Activities of which the associated returns or costs are currently unclear	.629	.626
(5) Activities requiring quite some adaptability	.679	.690
(6) Activities requiring you to learn new skills or knowledge	.606	.621
(7) Activities that are not (yet) clearly prescribed by existing policies, procedures or other guidelines	.638	.635
Job Demands	$\alpha = 0.899$	$\alpha = 0.899$
(1) Can you do your work comfortably? (Reversed)	X	X
(2) Do you have too little work? (Reversed)	X	X

(3) Do you have to work fast?	.494	.704
(4) Do you have too much work to do?	.745	.846
(5) Do you have to work extra hard to finish a task?	.720	.871
(6) Do you work under time pressure?	.539	.746
(7) Do you have to rush?	.448	.808
(8) Do you have to deal with a backlog at work?	.715	.684
(9) Do you have problems with the pace of work?	.744	.523
(10) Do you have problems with the workload?	.754	.501
(11) Do you wish you could work at an easier pace?	.764	.540
Job Control	$\alpha = 0.887$	$\alpha = 0.887$
(1) Can you choose the methods to use in carrying out your work?	.494	.512
(2) Do you plan your own work?	.745	.726
(3) Do you set your own pace?	.720	.714
(4) Can you vary how you do your work?	.539	.553
(5) On your job, do you have the freedom to take a break whenever you wish to?	.448	.443
(6) Do you decide on the order in which you do things?	.715	.729
(7) Do you decide when to finish a piece of work?	.744	.741
(8) Do you have full authority in determining how much time you spend on particular tasks?	.754	.769
(9) Can you decide how to get your job done?	.764	.768
(10) Does your job allow you to organize your work by yourself?	.808	.806
(11) Do you have full authority in determining the content of your work?	.559	.565
Job Social Support	$\alpha = 0.860$	$\alpha = 0.860$
(1) Can you rely upon your immediate supervisor when things get tough at work?	.682	.689
(2) If necessary, can you ask your immediate supervisor for help?	.715	.723
(3) Can you rely upon your colleagues when things get tough at work?	.881	.863
(4) If necessary, can you ask your colleagues for help?	.843	.837
Environmental dynamism	$\alpha = 0.796$	$\alpha = 0.796$
(1) In a year, nothing has changed in our market. (Reversed)	X	X
(2) Environmental changes in our market are intense.	.586	.592
(3) Our market regularly requires complete new products and services.	.715	.732
(4) In our market, changes are taking place continuously.	.665	.694
(5) In our market, the volumes of products and services to be delivered change fast and often.	.652	.678
Environmental Competitiveness	$\alpha = 0.880$	$\alpha = 0.880$
(1) Competition in our market is intense.	-.832	.829
(2) Our organization has relatively strong competitors.	-.817	.810
(3) Competition in our market is extremely high.	-.881	.874
(4) Price competition is a hallmark of our market.	-.649	.652
Job Intrinsic Motivation	$\alpha = 0.671$	$\alpha = 0.671$
(1) I enjoy finding solutions to complex problems.	.788	.778
(2) I enjoy creating new procedures for work tasks.	.616	.611
(3) I enjoy improving existing processes or products.	.757	.749

Extraction Method: Principal Component Analysis.

Rotation Method: **Direct Oblimin** with Kaiser Normalization / **Varimax** with Kaiser Normalization.

Table 13 : Descriptives, n=183

Panel A: Categorical variables

Frequencies		
Gender	Number	%
Male	129	71.3
Female	52	28.7
Prefer not to answer	2	/
Highest Degree	Number	%
Secondary education	2	1.1
Bachelor's degree	31	16.9
Master's degree	143	78.2
Doctor's degree	4	2.2
Other	1	.5
Prefer not to answer	2	/
Age		
≤ 1969	2	1.1
1970-1979	23	12.8
1980-1984	59	32.8
1985-1989	34	18.9
1990-1992	14	7.8
1993-1994	19	10.6
≥ 1995	29	16.1
Job experience (tenure within the sector)		
< 6 months	4	2.2
≥ 6 months and < 1 year	13	7.1
≥ 1 and < 2 years	22	12.0
≥ 2 and < 5 years	66	36.1
≥ 5 and < 10 years	29	15.8
≥ 10 and < 20 years	24	13.1
≥ 20 years	25	13.7
Sector	Number	%
Accountancy/Tax	3	1.6
Corporate finance	7	3.8
Engineering/Construction	28	15.3
Financial audit	4	2.2
IT (consultancy)	72	39.3
Legal services	29	15.8
Management/business consultancy	14	7.7
Marketing	4	2.2
Research & Development	4	2.2
Other	18	9.8

Firm	Number	%
CompanyX	57	31.1
Average project duration	Number	%
< 1 wk	6	3.3
1-2 wks	7	3.8
3-4 wks	14	7.7
2-3 months	26	14.2
4-6 months	28	15.3
7-12 months	40	21.9
> 1 year	62	33.9
Number of projects	Number	%
0-1 project	24	13.1
2-3 projects	68	37.2
4-6 projects	45	24.6
7-10 projects	14	7.7
11-15 projects	6	3.3
16-20 projects	3	1.6
>20 projects	23	12.6
Reimbursement of overtime	Number	%
No	146	83.0
Yes	30	17.0
Prefer not to answer	7	/

Panel B: Continuous variables

Dependent variables	N	Min.	Max.	Mean	Median	Std. Dev.
1. Job Fatigue	183	1.00	7.00	3.6279	3.6000	1.08903
Independent variables	N	Min.	Max.	Mean	Median	Std. Dev.
2a. Ambidexterity: Sum	183	5.51	14	8.491	8.4000	1.35449
2a. Ambidexterity: Sum (MC)	183	-2.98	5.51	.0000	-.0910	1.35449
2b. Ambidexterity: Cum	183	6.51	49	17.9714	17.1429	6.1301
2b. Ambidexterity: Cum (MC)	183	-4.29	7.58	-.0411	-.0044	1.07064
2.1. Exploitation	183	1.60	7.00	4.1366	4.2000	.86082
2.2. Exploration	183	1.71	7.00	4.3544	4.4286	1.08454
3. Job Demands	183	1.78	6.89	4.3813	4.3333	.97635
4. Job Control	183	1.82	7.00	5.0949	5.0909	.88565
5. Job Social Support	183	1.00	7.00	4.9454	5.0000	1.27034
6. JDEMxAmbidexteritySUM (both mean-centered)	183	-4.31	9.53	.2005	.0564	1.47577
7. JCONxAmbidexteritySUM (both mean-centered)	183	-11.50	7.49	.0993	.0491	1.47130
8. JSSUPxAmbidexteritySUM (both mean-centered)	183	-12.97	9.94	.0648	.0767	1.97480
Control variables	N	Min.	Max.	Mean	Median	Std. Dev.
9. Environmental Dynamism	183	1.00	7.00	4.7582	4.7500	1.24557
10. Environmental Competitiveness	183	1.00	7.00	5.3429	5.5000	1.11075
11. Job Intrinsic Motivation	183	2.33	7.00	5.7996	6.0000	.82612
12. Work Hours	183	23.00	70.00	48.0820	46.0000	8.54522

13. Commute Hours	183	.00	40.00	8.1202	8.0000	5.77288
15. Dummy Highest Degree: Mast. or Dr.	183	.00	1.00	.81420	1.0000	.39001
16. Dummy CompanyX	183	.00	1.00	.3115	0.0000	.46437

Table 14 : Distribution of Exploitation and Exploration

		Exploitation		
		Low (<4)	High (≥4)	
Exploration	Low (<4)	21 11%	41 ¹¹ 22%	62 34%
	High (≥4)	44 ¹¹ 24%	77 42%	121 66%
		65 36%	118 64%	

¹¹ An ANCOVA was used to determine any significant difference for the dependent variable Job Fatigue between two (unrelated) groups: High Exploitation & Low Exploration versus Low Exploitation & High Exploration. There were no significant differences for the adjusted means of respectively 3.418 (sd. 0.125) and 3.488 (sd. 0.120) when including covariates (Environmental Dynamism/ Environmental Competitiveness/ Job Intrinsic Motivation/ Work Hours/ Commute Hours/ Gender/ Highest Degree: Mast. or Dr, FirmX/ Job Demands/ Job Control/ Job Social Support). There neither are significant differences between the means for the these covariates.

Table 15: Correlation matrix (Pearson, two-tailed), n=183

Variable	Job Fatigue	Ambidex-terity	Exploita-tion.	Explora-tion	Job Dem.	Job Control	Job SocSup.	Environ. Dyn.	Environ. Comp.	Job Intr. Motiv.	Work Hours	Comm. Hours	Gender	Mast. or dr.
1. Job Fatigue	1	.083	.043	.070	.481**	-.306**	-.333**	.050	-.044	-.154*	.279**	.102	.082	.161*
2. Ambidexterity: Sum		1	.600**	.773**	.152*	.083	.038	.167*	.143	.297**	.162*	-.015	-.076	-.050
2.1. Exploitation			1	-.044	.165*	.106	.010	.063	.218**	.085	.133	-.038	-.035	-.170*
2.2. Exploration				1	.059	.019	.039	.159*	.006	.304**	.097	.012	-.067	.073
3. Job Demands					1	-.120	-.330**	.154*	.165*	-.043	.334**	.064	-.030	-.052
4. Job Control						1	.055	-.097	-.020	.160*	.058	-.216**	-.114	-.044
5. Job Social Support							1	.001	.004	-.031	-.219**	-.084	-.064	.029
6. Environmental Dynamism								1	.441**	-.002	.102	.165*	-.007	-.147*
7. Environmental Competitiveness									1	.023	.148*	.089	.013	-.151*
8. Job Intrinsic Motivation										1	.040	.048	-.009	-.002
9. Work Hours											1	.038	-.164*	.079
10. Commute Hours												1	.094	-.055
11. Gender													1	.016
12. Highest Degree: Mast. or Dr.														1

****** Correlation is significant at the 0,01 level (2-tailed) / ***** Correlation is significant at the 0,05 level (2-tailed)

Table 16 : Regression Analysis for Job Fatigue

Variables	Job Fatigue								
	B	β	p-value	B	β	p-value	B	β	p-value
Constant	2.889**		.000	3.345**		.000	4.466**		.000
1. Environmental Dynamism	.045	.052	.518	.024	.027	.737	-.040	-.046	.505
2. Environmental Competitiveness	-.105	-.108	.176	-.111	-.113	.154	-.129*	-.132*	.048
3. Job Intrinsic Motivation	-.222*	-.168*	.017	-.279**	-.211**	.004	-.225**	-.170**	.007
4. Work Hours	.040**	.314**	.000	.039**	.302**	.000	.022*	.171*	.013
5. Commute Hours	.018	.093	.200	.019	.100	.164	.004	.021	.727
6. Gender	.298	.124	.092	.322	.134	.067	.164	.068	.272
7. Highest Degree: Mast. or Dr.	.226	.081	.265	.270	.097	.184	.197	.071	.255
8. FirmX	.115	.049	.512	.186	.079	.296	.158	.067	.292
9. Ambidexterity				.117	.146	.061	.098	.122	.077
10. Job Demands							.407**	.365**	.000
11. Job Control							-.350**	-.284**	.000
12. Job Social Support							-.142**	-.165**	.010
13. JDEMxAmb							-.026	-.035	.579
14. JCONxAmb							.154**	.208**	.001
15. JSSUPxAmb							-.005	-.009	.890
N	183			183			183		
F-value	3.824**			3.846**			8.722**		
p-value	.000			.000			.000		
R²	.150**			.167**			.439**		

****** Significant at the 0.01 level (2-tailed) / ***** Significant at the 0.05 level (2-tailed)

Table 17: Regression Analysis for Job Fatigue w/o outliers

Variables	Job Fatigue ^a								
	B	β	p-value	B	β	p-value	B	B	p-value
Constant	3.132**		.000	3.485**		.000	4.546**		.000
1. Environmental Dynamism	.061	.072	.398	.039	.046	.592	-.032	-.038	.603
2. Environmental Competitiveness	-.123	-.129	.127	-.125	-.131	.120	-.125	-.131	.063
3. Job Intrinsic Motivation	-.188	-.145	.051	-.243*	-.187*	.017	-.195*	-.150*	.023
4. Work Hours	.033**	.254**	.002	.033**	.253**	.002	.017	.129	.060
5. Commute Hours	.010	.049	.520	.011	.057	.455	.003	.013	.839
6. Gender	.280	.118	.124	.295	.124	.103	.208	.088	.174
7. Highest Degree: Mast. or Dr.	.171	.062	.413	.235	.086	.266	.115	.042	.515
8. FirmX	.109	.048	.537	.182	.080	.314	.152	.067	.313
9. Ambidexterity				.120	.139	.087	.125*	.145*	.038
10. Job Demands							.379**	.342**	.000
11. Job Control							-.359**	-.282**	.000
12. Job Social Support							-.193**	-.214**	.001
13. JDEMxAmb							-.013	-.014	.825
14. JCONxAmb							.167*	.159*	.012
15. JSSUPxAmb							-.054	-.068	.284
N	177			177			177		
F-value	2.463*			2.543**			7.853**		
p-value	.015			.009			.000		
R ²	.105*			.121**			.423**		

** Significant at the 0.01 level (2-tailed) / * Significant at the 0.05 level (2-tailed)

Table 18: Regression Analysis for Ambidexterity

Variables	Ambidexterity			Ambidexterity		
	B	β	p-value	B	β	p-value
Constant	-3.893**		.000	-3.669**		.000
1. Environmental Dynamism	.185*	.170*	.031	.174*	.160*	.042
2. Environmental Competitiveness	.043	.036	.645	.024	.020	.796
3. Job Intrinsic Motivation	.483**	.295**	.000	.493**	.301**	.000
4. Work Hours	.013	.082	.269	.009	.058	.462
5. Commute Hours	-.012	-.051	.472	-.009	-.039	.586
6. Gender	-.206	-.069	.333	-.182	-.061	.394
7. Highest Degree: Mast. or Dr.	-.371	-.107	.132	-.325	-.094	.186
8. FirmX	-.608**	-.208**	.005	-.630**	-.216**	.003
9. Job Demands				.203	.146	.059
10. Job Control				.042	.028	.699
11. Job Social Support				.124	.117	.114
N	183			183		
F-value	5.217**			4.275**		
p-value	.000			.000		
R²	.193**			.216**		

****** Significant at the 0.01 level (2-tailed) / ***** Significant at the 0.05 level (2-tailed)

Table 19: Regression Analysis for Exploitation

Variables	Exploitation								
	B	β	p-value	B	β	p-value	B	β	p-value
Constant	-1.236		.054	-.997		.130	-1.250		.065
1. Environmental Dynamism	-.015	-.021	.794	-.019	-.027	.744	.000	.000	.995
2. Environmental Competitiveness	.149*	.192*	.019	.138*	.178*	.030	.127*	.164*	.046
3. Job Intrinsic Motivation	.085	.082	.257	.080	.077	.291	.119	.115	.136
4. Work Hours	.010	.097	.216	.006	.058	.480	.006	.062	.456
5. Commute Hours	-.010	-.066	.371	-.007	-.047	.537	-.007	-.048	.523
6. Gender	-.027	-.014	.850	-.010	-.005	.943	-.026	-.014	.853
7. Highest Degree: Mast. or Dr.	-.365*	-.165*	.027	-.333*	-.151*	.044	-.332*	-.151*	.043
8. FirmX	-.215	-.116	.131	-.221	-.119	.120	-.260	-.140	.072
9. Job Demands				.130	.148	.070	.137	.155	.056
10. Job Control				.083	.085	.263	.079	.081	.284
11. Job Social Support				.046	.068	.379	.054	.079	.308
12. Exploration							-.095	-.119	.128
N	183	183		183	183		183	183	
F-value	2.611**	2.611**		2.309*	2.309*		2.328**	2.328**	
p-value	.010	.010		.012	.012		.009	.009	
R²	.107**	.107**		.129*	.129*		.141**	.141**	

****** Significant at the 0.01 level (2-tailed) / ***** Significant at the 0.05 level (2-tailed)

Table 20: Regression Analysis for Exploration

Variables	Exploration								
	B	β	p-value	B	β	p-value	B	β	p-value
Constant	-2.657**		.001	-2.672**		.001	-2.815**		.001
1. Environmental Dynamism	.200**	.229**	.005	.192**	.221**	.007	.190**	.218**	.007
2. Environmental Competitiveness	-.106	-.108	.172	-.113	-.116	.146	-.094	-.096	.234
3. Job Intrinsic Motivation	.398**	.303**	.000	.413**	.314**	.000	.424**	.323**	.000
4. Work Hours	.003	.026	.734	.003	.026	.751	.004	.032	.688
5. Commute Hours	-.002	-.011	.882	-.002	-.012	.874	-.003	-.017	.817
6. Gender	-.179	-.075	.304	-.172	-.072	.329	-.173	-.072	.323
7. Highest Degree: Mast. or Dr.	-.006	-.002	.978	.008	.003	.968	-.040	-.014	.845
8. FirmX				-.409*	-.175*	.020	-.441*	-.189*	.013
9. Job Demands				.072	.065	.412	.091	.082	.305
10. Job Control				-.040	-.033	.658	-.028	-.023	.755
11. Job Social Support				.078	.091	.228	.085	.099	.190
12. Exploration							-.144	-.114	.128
N	183	183		183	183		183	183	
F-value	4.086**	4.086**		3.132**	3.132**		3.088**	3.088**	
p-value	.000	.000		.001	.001		.001	.001	
R ²	.158**	.158**		.168**	.168**		.179**	.179**	

**** Significant at the 0.01 level (2-tailed) / * Significant at the 0.05 level (2-tailed)**

SURVEY

About this research

This survey aims at a better understanding of the **stress level** and **job activities within projects**. To that extent, we would like to call upon your expertise and personal job experiences.

The study is conducted by drs. Ward Reynaert, in cooperation with prof. dr. Patricia Everaert and prof. dr. Werner Bruggeman.

Practical information

- This questionnaire is intended for **employees** and **managers** who are often **involved in projects**. A project is each temporary endeavor undertaken to deliver one or more products or services for a specified business case. Projects often occur in businesses such as architecture, audit, consultancy, construction, engineering, IT, legal services, research & development...
- There are **no correct or wrong answers**. Some questions may be less relevant to your particular job. Always try to respond with the most suitable answer given your specific job.
- The **anonymity** of all participants is ensured. All **data is collected anonymously**; responses are disconnected from respondents at all time. The researchers use the data for statistical analysis and only general findings are disclosed.
- The questionnaire will take approximately **12 minutes** to complete

Thank you for participating!

drs. Ward Reynaert, prof. dr. Patricia Everaert, prof dr. Werner Bruggeman

Ghent University,
Faculty of Economics and Business Administration,
Department of Accounting, Corporate Finance and Taxation
Sint-Pietersplein 7, 9000 Ghent

Sector and job experience

In which sector do you work?	Accountancy/Tax Corporate finance Engineering/Construction Financial audit IT (consultancy) Legal services Management/business consultancy Marketing Research & Development Other
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	<i>< 6 months</i>	<i>≥ 6 months and < 1 yr</i>	<i>≥ 1 and < 2 years</i>	<i>≥ 2 and < 5 years</i>	<i>≥ 5 and < 10 years</i>	<i>≥ 10 and < 20 years</i>	<i>≥ 20 years</i>
For how long have you been working in your this sector?	0	0	0	0	0	0	0

Project duration and number of projects

	<i>< 1 wk</i>	<i>1-2 wks</i>	<i>3-4 wks</i>	<i>2-3 months</i>	<i>4-6 months</i>	<i>7-12 months</i>	<i>> 1 year</i>
What is the average duration of the projects you have been involved in during the past six months?	0	0	0	0	0	0	0

	<i>0-1 project</i>	<i>2-3 projects</i>	<i>4-6 projects</i>	<i>7-10 projects</i>	<i>11-15 projects</i>	<i>16-20 projects</i>	<i>>20 projects</i>
In how many projects have you usually been involved simultaneously during the past six months?	0	0	0	0	0	0	0

Working hours and journey to and from work

	0h	70 h
How many hours per week do you work on average? Please indicate the total number of hours actually worked per week, including any (unpaid) overtime.		

Slider: between 0 and 70 hours

	0h	h	40 h
How many hours per week do you commute between work and home on average?			

Slider: between 0 and 40 hours

Can overtime work be recovered by additional holidays or pay?	<input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> I prefer not to answer
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Work activities

To what extent have you been doing the following project activities in the past six months?

	To a very small extent	To a small extent	To a rather small extent	Neutral	To a rather large extent	To a large extent	To a very large extent
(1) Activities of which a lot of experience has been accumulated by yourself	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(2) Activities which you carry out as if it were routine	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(3) Activities which serve existing customers with existing services/products	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(4) Activities of which it is clear to you how to conduct them	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

(5) Activities primarily focused on achieving short-term goals	0	0	0	0	0	0	0
(6) Activities which you can properly conduct by using your present knowledge	0	0	0	0	0	0	0
(7) Activities that are clearly prescribed by existing policies, procedures or other guidelines	0	0	0	0	0	0	0

To what extent have you been doing the following project activities in the past six months?

	To a very small extent	To a small extent	Rather to a small extent	Neutral	Rather to a large extent	To a large extent	To a very large extent
(8) Searching for new possibilities with respect to products/services, processes or markets	0	0	0	0	0	0	0
(9) Evaluating diverse options with respect to products/services, processes or markets	0	0	0	0	0	0	0
(10) Focusing on strong renewal of products/services or processes	0	0	0	0	0	0	0
(11) Activities of which the associated returns or costs are currently unclear	0	0	0	0	0	0	0
(12) Activities requiring quite some adaptability	0	0	0	0	0	0	0
(13) Activities requiring you to learn new skills or knowledge	0	0	0	0	0	0	0
(14) Activities that are not (yet) clearly prescribed by existing policies, procedures or other guidelines	0	0	0	0	0	0	0

Work environment

Frequency

	Never	Very rarely	Rarely	Half the time	Often	Very often	Always
(1) Can you choose the methods to use in carrying out your work?	0	0	0	0	0	0	0
(2) Do you plan your own work?	0	0	0	0	0	0	0
(3) Do you set your own pace?	0	0	0	0	0	0	0
(4) Can you vary how you do your work?	0	0	0	0	0	0	0
(5) On your job, do you have the freedom to take a break whenever you wish to?	0	0	0	0	0	0	0
(6) Do you decide on the order in which you do things?	0	0	0	0	0	0	0
(7) Do you decide when to finish a piece of work?	0	0	0	0	0	0	0
(8) Do you have full authority in determining how much time you spend on particular tasks?	0	0	0	0	0	0	0
(9) Can you decide how to get your job done?	0	0	0	0	0	0	0
(10) Does your job allow you to organize your work by yourself?	0	0	0	0	0	0	0
(11) Do you have full authority in determining the content of your work?	0	0	0	0	0	0	0

Frequency

	Never	Very rarely	Rarely	Half the time	Often	Very often	Always	N/A
(1) Can you rely upon your immediate supervisor when things get tough at work?	0	0	0	0	0	0	0	0

(2) If necessary, can you ask your immediate supervisor for help?	0	0	0	0	0	0	0	0
(3) Can you rely upon your colleagues when things get tough at work?	0	0	0	0	0	0	0	0
(4) If necessary, can you ask your colleagues for help?	0	0	0	0	0	0	0	0

Frequency

	Never	Very rarely	Rarely	Half the time	Often	Very often	Always
(1) Can you do your work comfortably? (reversed item)	0	0	0	0	0	0	0
(2) Do you have too little work? (reversed item)	0	0	0	0	0	0	0
(3) Do you have to work fast?	0	0	0	0	0	0	0
(4) Do you have too much work to do?	0	0	0	0	0	0	0
(5) Do you have to work extra hard to finish a task?	0	0	0	0	0	0	0
(6) Do you work under time pressure?	0	0	0	0	0	0	0
(7) Do you have to rush?	0	0	0	0	0	0	0
(8) Do you have to deal with a backlog at work?	0	0	0	0	0	0	0
(9) Do you have problems with the pace of work?	0	0	0	0	0	0	0
(10) Do you have problems with the workload?	0	0	0	0	0	0	0
(11) Do you wish you could work at an easier pace?	0	0	0	0	0	0	0

Job fatigue

Frequency

	Never	Very rarely	Rarely	Half the time	Often	Very often	Always
(1) In general, I feel rather fit after dinner. (reversed item)	0	0	0	0	0	0	0
(2) I find it difficult to relax at the end of a working day.	0	0	0	0	0	0	0
(3) At the end of a working day, I feel really fatigued.	0	0	0	0	0	0	0
(4) Due to my job, I feel rather exhausted at the end of a working day.	0	0	0	0	0	0	0
(5) I usually do not calm down until my second day off.	0	0	0	0	0	0	0
(6) After work, it takes effort to concentrate in my spare time.	0	0	0	0	0	0	0
(7) When I just come home, I have little interest in other people.	0	0	0	0	0	0	0
(8) In general, it takes me more than an hour to recover completely after work.	0	0	0	0	0	0	0
(9) When I come home, they must leave me alone for a while.	0	0	0	0	0	0	0
(10) After a working day, I frequently feel too fatigued to engage in any other activity.	0	0	0	0	0	0	0
(11) During the last stage of a working day, I often feel too fatigued to perform well.	0	0	0	0	0	0	0

Job satisfaction

Please indicate your level of satisfaction.

	Very unsatisfie d	Mode- rately unsatisfie d	Slightly unsatisfie d	Neutral	Slightly satisfied	Moderat ely satisfied	Very satisfied	N/A
(1) All in all, how satisfied are you with the job content?	0	0	0	0	0	0		0
(2) All in all, how satisfied are you with your colleagues?	0	0	0	0	0	0		0
(3) All-in all, how satisfied are you with the supervision by your supervisors?	0	0	0	0	0	0		0

Market

To what extent do you agree with the following statements?

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
(1) In a year, nothing has changed in our market. (Reversed)	0	0	0	0	0	0	0
(2) Environmental changes in our market are intense.	0	0	0	0	0	0	0
(3) Our market regularly requires complete new products and services.	0	0	0	0	0	0	0
(4) In our market, changes are taking place continuously.	0	0	0	0	0	0	0
(5) In our market, the volumes of products and services to be delivered change fast and often.	0	0	0	0	0	0	0

To what extent do you agree with the following statements?

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
(1) Competition in our market is intense.	0	0	0	0	0	0	0
(2) Our organization has relatively strong competitors.	0	0	0	0	0	0	0
(3) Competition in our market is extremely high.	0	0	0	0	0	0	0
(4) Price competition is a hallmark of our market.	0	0	0	0	0	0	0

Job preferences

Please indicate the extent to which you agree that you enjoy doing the following things.

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
(1) I enjoy finding solutions to complex problems.	0	0	0	0	0	0	0
(2) I enjoy creating new procedures for work tasks.	0	0	0	0	0	0	0
(3) I enjoy improving existing processes or products.	0	0	0	0	0	0	0

Demographics and education

Gender	Male Female Prefer not to answer
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Year of birth	≤ 1969 1970-1979 1980-1984 1985-1989 1990-1992 1993-1994 ≥ 1995 Prefer not to answer
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Highest degree	Secondary education Bachelor's degree Master's degree Doctor's degree Other Prefer not to answer
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If you want a **summary of the research findings**, please contact Ward Reynaert (M: Ward.Reynaert@UGent.be)

Thank you for taking the time to participate in this study. Your time is greatly appreciated.

Discussion

Antecedents of ambidexterity across levels of analysis and across time

Ambidexterity literature indicated a need for empirical studies that consider different types of antecedents, different levels of analysis, and interactions. I found that a highly standardized turnaround process by means of structures, procedures and metaroutines contributed to project ambidexterity. Structural, sequential, contextual and leadership-based antecedents were **all** used when considering **different levels of analysis across the course of project**. Leadership-based antecedents and contextual antecedents demonstrated direct effects on exploration and exploitation, as well as their potential to influence the effectiveness of structural, and sequential antecedents. Leadership-based antecedents even influenced the effectiveness of contextual antecedents.

Quite some examples of **contextual antecedents** could be examined. The planning teams, the crash team during the turnaround execution, the people involved in the lessons learned processes, and the members of the TAR management team, were all combining exploitation and exploration to some extent at some time during the project. Even the headman of the subcontractors that were hired to execute the work according to the planning, got some freedom to optimize their work activities. Only the mechanical workers that did the mechanical work during the execution, had to be exclusively focused on the efficient execution of previously planned work. The work executed by the mechanical workers, was earlier planned by planning teams and further specified by the headmen of the contractor firms. It was a clear example of a successful use of dual structures to achieve ambidexterity. At the same time planning teams, crash team, TAR management etc. were not relying on dual structures, but successfully combined exploitation and exploration at the individual level. As such we thus noticed that dual structures do exist, but they do not give the whole story as mentioned by Birkinshaw, and Gupta (2013). The case findings also illustrated some **structural separation** that was not the typical separation between exploration and exploitation. During the planning, for instance, I observed how the planning of the whole turnaround was divided and decentralized to three planning teams. The IMR-work, HI-work and DCS-work was prepared by specific teams with more relevant knowledge and experience. Each team contributed to both exploitation and exploration. So the differentiation within the separate units was not between exploitation and exploration, but between teams doing ambidexterity activities for a more specific work objective.

O'Reilly, and Tushman (2013) question how major changes occur in case of contextual ambidexterity. They consider it conceptually understandable that contextual ambidexterity can operate within a given setting or technological regime, but find it harder to understand how it permits firms to adjust to disruptive or discontinuous changes in technologies and markets. The project illustrates that incremental and radical innovation could occur by a different focus at different moments in the planning, which indicates the importance of **sequential antecedents**. Despite studies claim that firms shift structures between exploitative and exploratory modes, O'Reilly, and Tushman (2013) notice a high level of abstraction and not enough clarity how sequential ambidexterity occurs and what the transition looks like at ground level. Turnaround projects normally have a main focus on incremental innovation during the planning of the actual turnaround. However, in this specific case, considerable radical innovation was necessary as well because current best practices needed to be surpassed by far. Therefore TAR management involved and stimulated top-down all planners to explore a lot more than

usual. It was quite unique that such a large exploratory efforts occurred during the planning. In addition, each turnaround project, there is a lessons-learned process post-shutdown. Besides lessons-learned with regard to descriptions of work activities, updated policies and procedures etc., everybody is at that moment post-shutdown also stimulated to come up with incremental or even radical new ideas. So here there is space for radical new ideas as well. Apart from the turnaround projects, each installation management also has some ongoing program that stimulates employees to share new ideas when daily operations are going on. This is again organized by means of parallel structures. Both examples allow to capture incremental improvement or radically new ideas. These ideas can then be developed further and implemented later on. Like this was illustrated how sequential antecedents relied on parallel structures, metaroutines, and switching to combine routine and non-routine tasks.

The case study also allowed some interesting insights with regard to **leadership-based antecedents**. TAR management itself consisted of experienced people that were able to combine exploitation and exploration. They contributed themselves, directly, to exploitation and exploration. Besides they were very important by facilitating structural, sequential, and contextual antecedents of ambidexterity. They used their networks within and outside the firm to get access to new knowledge, competences, and capabilities. They implemented structural separation and stimulated integration as well. They implemented the project cycle and sequentially switched the emphasis on exploitation and exploration. Furthermore they led by example and demonstrated certain socio-ideological controls, while also facilitating and stimulating individuals to demonstrate exploitation and/or exploration.

The observation that **different antecedents of ambidexterity were combined in one project**, is in line with earlier literature. O'Reilly, and Tushman (2013) categorize inter-organizational antecedents as structural antecedents at the inter-organizational level. They found that ambidexterity may be achieved by combining different antecedents of ambidexterity across levels. They refer to several in-depth studies that find ambidexterity facilitated by a combination of these antecedents at organizational or inter-organizational levels, and across the course of time. They pledge to leave a focus on single antecedents and merely an organizational or inter-organizational level. They differentiated between structural, sequential, and contextual antecedents, and the organizational as well as inter-organizational level. We considered leadership-based antecedents as well, and included more levels of analysis. An interesting findings was that contextual and leadership-based antecedents facilitated the implementation of structural and sequential antecedents. Leadership-based antecedents also contributed to the implementation of contextual antecedents

An important limitation is that only once case study in one context was done. O'Reilly, and Tushman (2013) concluded that there is not one single way to handle ambidexterity. *"organizational ambidexterity, whether sequential, structural, or contextual, may, under the appropriate circumstances, be an effective way for organizations to deal with the challenges of exploitation and exploration."* (O'Reilly & Tushman, 2013, p. 330) The appropriateness of ambidexterity types depends on the **context**. For instance, the **environment** or the **timing** can influence which combinations of antecedents are most appropriate. (O'Reilly & Tushman, 2013, p. 330). Structural antecedents can, for instance, be more appropriate in case of dynamic markets whereas sequential antecedents may be better suited with sequential antecedents. Or structural antecedents can be helpful to allow exploration for incumbent firms whereas more integrated structures can better fit the needs when the firm becomes more mature (O'Reilly & Tushman, 2013). O'Reilly, and Tushman (2013) referred, for instance, to studies describing firms that initially relied on structural antecedents and integrated the parts into one unit where contextual antecedents were applied, to later switch back to structural antecedents. More research is needed to bring into the light alternative approaches to handle ambidexterity.

Management control

The findings of paper 2 allow some very interesting conclusions. Despite there obviously was project ambidexterity and a hybrid control package at the project level, more focused case study research allowed to unravel this further. The **hybrid control package** was an **overall toolbox** that TAR management had at its disposal. Nevertheless, the **emphasis on specific control practices differed over time** and even **between structurally separated units at the same time**. In fact different control packages could be noticed if we went down and focused on a more specific level. We contributed to literature by clarifying that organizations change emphasis in their control approach to strive for changing objectives.

Bedford, and Malmi (2015) found five typical packages which were linked to a specific context. This approach could indicate some internal fit of the taxonomy of packages. All packages are likely to be the result of control packages that, over the years, have been changed by management to improve the association between MC practices as well as the performance effects of the combined package in a certain context. So one could assume that the observed packages of controls is the result of well-considered design choices that take interdependencies between controls and performance effects into consideration. The five packages can be the result of optimizing management control packages for a certain context. Nevertheless, I see different problems with this approach. First, linking these packages with environments seems not totally appropriate to me. Top managers filled in both the survey about the controls as well as about the environment, but the perception of the environment can be influenced by the available controls. More results and action control can, for instance, result in a higher perceived outcome measurability or task programmability. *Ceteris paribus*, more controls can also make that the environment looks less turbulent, less complex, less hostile, and more predictable. A second problem I have is that the questionnaire asks which controls are in place. Despite the co-existence allows the possibility of interdependencies, it is not certain interdependencies exists. Additional empirical research is necessary to test for interdependency. Third, the observed package, for instance a hybrid package, is just the overall packages indicated by the manager. It is not clarified if the overall packages is collection of different controls or systems that are applied at different moments. More empirical, and longitudinal research, research is necessary. The study indicates the co-existence, but not how controls are used together. Bedford, and Malmi (2015) mentioned that the taxonomy reflects general empirical tendencies that need further systematic investigation to develop more complete explanations. Existing frameworks do not adequately explain how they function and in which contexts they may be most effective (Bedford & Malmi, 2015).

Bedford, and Malmi (2015) found five packages: simple control packages (C1), results control packages (C2), action control packages (C3), devolved control packages (C4), and hybrid control packages (C5). We start with the differences between the case observations and the taxonomy of five packages Bedford, and Malmi (2015) retrieved in practice by means of survey research.

Simple control packages rely on largely informal control and coordination, using centralised decision-making, restricted autonomy, and direct supervision. However, all controls are used to a low or moderate level. Considering we did not notice simple control practices in our case, we will not discuss it in detail.

Results and action control packages have similar bureaucratic underpinnings. Both are characterized by a high level of output and behavioural control, with a main focus on results for the results control package and a main focus on compliant behaviour for the action control package. Results control packages are characterized by diagnostic control and tight follow-up using accounting systems.

Accounting information is also used for objectively determined, performance-based compensation. Action control packages achieve individual accountability by centralised authority, direct monitoring, restricted autonomy, formal planning, standardized rules and procedures, and well defined boundaries of conduct. Other characteristics are the tall hierarchy and vertical, routinized and restricted patterns of communication.

Both results and action control packages were noticed during the execution of the turnaround work. In fact we need to consider three different groups that were involved in the efficient execution of the prepared work according to the planning by means of a bureaucratic structure. First there were the subcontractors. These could be split into two groups. On the one hand the contractors delivered mechanics who faced something in between action and results control packages with a main focus on action control. On the other hand the contractors delivered headman, supervisors, and managers who faced something in between action and results control packages with a main focus on result control. The main difference with the packages found in Bedford, and Malmi (2015) was a different emphasis on socio-ideological controls. A third group were the own ChemBE people involved in the execution of the mechanical work during the turnaround. They faced a clear action control package.

Headman, supervisors, and managers of the contractors received a planning which they needed to execute. That planning, however, sometimes required some additional more fine-grained work preparation that needed to be done in advance. The exact planning of all work activities needed to be delivered to the TAR scheduler and there was a tight follow-up of budgeted costs, timing, as well as safety restrictions when considering the planning upfront as well as diagnostic control during the TAR execution. Contractors got performance-based compensation based on objective targets. ChemBe did quite some efforts that triggered socio-ideological mechanisms as well which is more typical for action control, but control mainly relied on objectives and performance-based compensation for contractors and their management. The contractor organization also faces quite some other characteristics of the results control package in the way they are controlled (Bedford & Malmi, 2015). They have limited participation in strategy formation. They need to focus primary attention towards short-term financial performance. They face a top-down implementation with formal, vertical channels of communication containing directives and performance feedback. TAR management does use exception-based monitoring to maintain control at a distance and to intervene to modify behaviours when the contractor deviates from expected outcomes. Contractors do receive some individual autonomy and decision rights that provide limited flexibility in the way they handle local contingencies but at the same time the emphasis on performance dimensions and their rigid enforcement do restrict their activities. Hierarchical accountability systems are used to let contractors internalise efficiency and productivity as dominant norms

Despite contractor firms did get performance-based compensation, these organizations normally do not apply performance-based compensation to their mechanical workers. Opposite to the management control package characteristics found by Bedford, and Malmi (2015), there neither was a reliance on socio-ideological mechanisms. ChemBE did require some trainings from each contractor employee where they tried to transmit some values and norms, however, they indicated as well that it remains difficult to get socio-ideological alignment when working with temporary staff. Contractors mainly controlled their mechanical work staff by means of centralised authority, direct monitoring, restricted autonomy, formal planning, standardized rules and procedures, and well defined boundaries of conduct. Furthermore we noticed control by means of *“a tall hierarchy (>C4) and vertical, routinised and restricted patterns of communication (>C4,C5) that serve to reinforce positional authority and hierarchical accountability (Mintzberg, 1979)”* (Bedford & Malmi, 2015, p. 14). Furthermore, accounting is used in addition to direct managerial supervision *“diagnostic and tight use of accounting*

is significantly lower than results control (C2), as is the use of performance-based compensation, suggesting that accounting has reduced importance for securing individual performances. Instead accounting may function as a supplement to the direct observations of top management in the evaluation of task execution, forming part of the feedback loop in refining the specifications of roles and procedures.” (Bedford & Malmi, 2015, p. 14-15).

Own ChemBE personnel involved in the execution of mechanical work did face a similar action control package. Nevertheless, for own ChemBE personnel there was a high reliance on socio-ideological control mechanisms as well.

One important contribution to Bedford, and Malmi (2015) their contextual findings is that employees of the same contractor, responsible for the same work, in fact faced two different control packages depending on their place on the hierarchical level. Also the context differed for the different levels of analysis. Headman of contractor firms, for instance, get a clear work package that they need to prepare. This could be considered as a results control package in a stable environment where they got tight accountability to predetermined targets. Mechanics of the same contractor firm, however, need to follow the exact work planning prepared by their headmen and these do face a higher level of action control. The control packages may differ according to the different objectives for both groups, rather than because of any contextual differences. Contractor organizations and their management try to optimize financial performance and a results control package is effective while doing this. Contractors' their mechanics need to demonstrate compliant behavior and face an action control package. Behavioral control allows supervisors to monitor actions of mechanics and assure immediate reaction in case of deviations. In that way action control for the mechanics creates a stable environment, while it allows supervisors to immediately react to changes in the environment. Rather than the context that determines the package, this would mean that objectives can determine the package. And these objectives can be different across different levels of analysis. This observation reinforces my thoughts that the perception of an environment can be influenced by the controls as well. It is possible that within the same business context a focus on optimal results or compliant behavior and applying respectively a results or an action control package, influences the perception of competitiveness or change from the individual point of view.

The devolved control package found by Bedford, and Malmi (2015) was characterized by: *“a flat hierarchy (>all), emergent and lateral communication channels (>all), employment of integrative liaison devices (>C1,C2; =C3,C5), significant individual autonomy (>C1,C2,C3), long-term performance assessment (>all), reliance on socialization processes and social controls (>C1,C3,C5), and reduced emphasis on standardised behavioural routines (<C2,C6) and predetermined performance targets (<C2,C5).”* (Bedford & Malmi, 2015, p. 15). Furthermore Bedford, and Malmi (2015, p. 15) mentioned that the locus of authority is typically shifted from managers to subordinates, and coordination primarily occurs through self-organization and mutual adjustment.

These control practices were clearly applied during the discussion of new ideas post-shutdown. Post-shutdown there was a lessons learned process where all lessons learned were captured. Besides these lessons learned, there was room to discuss problems or come up with new ideas. Nevertheless, managerial influence was *“quite limited and largely informal in nature, centred upon active engagements in lateral coordination and the shaping of shared expectations”* (Bedford & Malmi, 2015, p. 15). This is, however, in line with the ideal type descriptions but not the typical “devolved control package” retrieved by Bedford, and Malmi (2015, p. 15-16) who found that devolved control packages do have a rather strong presence of formal control mechanisms:

“Boundary controls and pre-action reviews are utilised to a similar extent as action control (C3), although combined in an otherwise organic structure they likely have an enabling role (Adler and Borys, 1996). Measurement systems also appear to be important in this configuration. Rather than tightly specifying individual accountabilities (<C2,C5), broad-scope (>C1,C2) accounting controls are used to direct attention, encourage novel behaviours, and facilitate an open sharing of information, the latter of which Speklé (2001) argues to be essential in exploratory control structures for equitable performance assessments.”

Such a controls were, however, used to capture all lessons-learned post-shutdown. Pre-action reviews could be stored in the library for later, measured deviations from objectives were used to come up with appropriate lessons etc. The focus was clearly on long-term performance. It illustrates that even the devolved control package can be used with a different emphasis on its diverse elements.

Similar to Bedford, and Malmi (2015), the devolved control package was used when striving for innovation. Nevertheless, it was also a way to capture lessons learned and become more efficient. Bedford, and Malmi (2015) further indicated it is mainly appropriate in unpredictable and turbulent environments, but our case study illustrated that a devolved control package could also be used in a quite stable environment to focus on innovation. So again it illustrates that the control package can enable to strive for certain objectives, rather than it is contingent on the context. It would also clarify why Bedford, and Malmi (2015) found that devolved control is viable under a range of contextual circumstances.

One specific situation where a devolved control package was noticed in an unpredictable and turbulent environment, was the early stage of the planning. At that point we also noticed typical *“relatively high levels of subordinate participation in strategic planning (>C1,C2,C3*) and communication of organizational values through belief systems (>C1,C2)”* (Bedford & Malmi, 2015, p. 15). The devolved control package noticed at the beginning of the planning did rely on measurement as well. This is again in line with Bedford, and Malmi (2015, p. 16): *“Measurement systems also appear to be important in this configuration. Rather than tightly specifying individual accountabilities (<C2,C5), broad-scope (>C1,C2) accounting controls are used to direct attention, encourage novel behaviours, and facilitate an open sharing of information, the latter of which Speklé (2001) argues to be essential in exploratory control structures for equitable performance assessments”*. Again there also was a rather strong presence of formal control mechanisms. The overall organic structure contained boundary controls and pre-action reviews that were used in an enabling way. At the beginning of the project planning phase there were still quite some uncertainties. During the planning phases, unknowns became known as the planning progressed. The use of social-ideological mechanisms staid high, but the use of action and result control increased. During the planning phase the control package like this evolved from a devolved towards a hybrid control package.

A hybrid control package represents *“the most elaborated arrangement, characterised by an intensive and demanding application of accounting and a significant bureaucratic apparatus”* (Bedford & Malmi, 2015, p. 16). It is characterized by:

“tightly emphasised accountabilities(>C1,C3,C4) to a wide array of metrics (>all) coupled with strong performance-based incentives (>C1,C3,C4), while strategic planning, boundary systems, standardization, and pre-action reviews are equal or greater in emphasis than other clusters” (Bedford & Malmi, 2015, p. 16)

“Balanced against this is a high level of participation in strategic planning (>C1,C2,C3), delegated decision authority (>C1,C3),discretion in conducting work activities (>C1,C3), moderately organic patterns of interaction (>C2,C3), and use of lateral integrative devices

(>C1,C2), indicating quite complex modes of integration and coordination. Reliance on socio-ideological controls is also significantly higher than all other clusters.” (Bedford & Malmi, 2015, p. 16)

The hybrid control package is named after this intermeshing of multiple control types and control modes. It combines controls focused on results control, behavioral control, as well as motivation by socio-ideological controls. It was found most in contexts characterized by high administrative technology (>all), large size (>C1,C3), and age (highest proportion of mature age firms) (Bedford & Malmi, 2015). I refer to the following interesting suggestion by Bedford, and Malmi (2015, p. 16):

“As Alvesson and Kärreman (2004) demonstrate in a management consultancy firm, this interweaving of bureaucratic and socio-ideological controls may provide an alternative, and possibly substitutable, way of organizing in relatively dynamic and complex conditions. The structural tensions inherent in such a configuration, and the association with multiple strategic priorities, also supports theories of ambidexterity that posit that complex combinations of mechanistic and organic structures are required to balance the competing objectives of efficiency and flexibility (Raisch and Birkinshaw, 2008).” (Bedford & Malmi, 2015, p. 16)

Such a hybrid package was used when planning a turnaround project, during the execution of discovery scope by the crash team during the execution, and by TAR management itself during planning, execution and post-shutdown. An important remark was that the TAR department facilitated ambidexterity with a well-structured, standardized approach and specific TAR leadership practices. Another important remark is that almost all people involved in ambidexterity were own company personnel that were socio-ideologically aligned and had quite some experience.

Job fatigue

The ability to combine exploration and exploitation does not tell how individuals experience it when they have to combine exploration and exploitation at the individual level. This was the topic of the third paper: does striving for ambidexterity causes job fatigue?

Paper 3 illustrates by means of survey research that ambidexterity has a significant positive effect on job fatigue. The higher the level of ambidexterity, and thus the higher the conflicting goals experienced by the individual, the higher the level of job fatigue. So people who combine exploitation and exploration, do experience higher job fatigue. We find that job demands (+), job control (-) and job social support (-) have an effect on job fatigue. Job demands have a positive effect on job fatigue. The higher the experienced job demands, the higher the job fatigue. Job control and job social support, ceteris paribus, reduce job fatigue. Nevertheless, there is a positive interaction effect of ambidexterity and job control on job fatigue. It implies that the higher the level of ambidexterity, the lower the reduction effect of job control on Job Fatigue. So whereas higher job demands (+) are associated with higher job fatigue, job control (-) and job social support (-) can counterbalance this.

The findings are relevant for business. Managers who are aware of the necessary project management characteristics that explain variances in Job Fatigue, can try to manage job fatigue among project workers. We have two very clear recommendations. (1) Organizations need to increase job social support. It reduces job fatigue. (2) We would also suggest that can facilitate higher job control which reduces job fatigue. Nevertheless, this becomes less effective for higher levels of ambidexterity. In addition, the findings showed that organizations need to select coworkers who are intrinsically motivated to explore if these coworkers are required to demonstrate ambidexterity. These coworkers will be less fatigued by a high level of ambidexterity. organizations

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Conclusion

“Not all firms that attempt to be ambidextrous are successful. It would be useful to know what distinguishes among these.” (O’Reilly & Tushman, 2013, p. 333)

We contributed to the ambidexterity literature by illustrating by means of **case study evidence** how ambidexterity was achieved successfully. Project ambidexterity was first unravelled into the different antecedents of ambidexterity. Then we unravelled how a hybrid control package was used to successfully manage this project ambidexterity. Unsuccessful firms may learn from this inspiring case.

The **first study** illustrates how the **four antecedents of ambidexterity** can explain project ambidexterity. We describe how a project team in a chemical firm successfully achieved project ambidexterity in a turnaround project at the occasion of a plant shutdown. Hereby (1) *all four antecedents of ambidexterity* could be observed (i.e., structural, sequential, contextual and leadership-based antecedents). Furthermore, (2) *no inconsistencies* and (3) *some complementarities* between the antecedents of ambidexterity were observed. The case study findings clearly demonstrate that it is possible to explain project ambidexterity by considering a combination of the four different antecedents of ambidexterity. A limited focus that does not consider all antecedents of ambidexterity across the different levels of analysis, could overestimate the effect of the considered antecedents of ambidexterity while the observed antecedents only partially explain by the pretended relation. Further research is necessary to investigate to which extent the demonstrated usefulness of this approach can be generalized.

The **second study** demonstrates that a **hybrid control package** fostered exploration and exploitation during the project case. The results demonstrate that a hybrid control package, combining diverse control practices, facilitated to foster both exploration and exploitation simultaneously. Additionally, we describe how combinations of controls were used to foster exploration and/or exploitation, whereby the emphasis on specific controls as well as on their influence on exploration and/or exploitation varied during the different project phases. No incompatible needs for exploration and exploitation were noticed when they were combined which substantiated the orthogonal ambidexterity view. Furthermore, we found that the hybrid control package stimulated single as well as double learning. This learning in turn stimulated timely adaptation of the control package to changes in the complex dynamic environment. Future research should focus on external validity to verify if a hybridization of management controls can foster similar positive results in other contexts or if other packages than the one used in this case study can be as effective when striving for ambidexterity.

Furthermore, we relied on **survey research** to find that ambidexterity activities at the individual level and reasonable job fatigue can be combined.

The survey data in the **third study** demonstrated that an individual project worker who needs to combine exploration and exploitation in his daily project work does experience a higher job fatigue. So striving for ambidexterity is linked with increased Job Fatigue. Furthermore, the results show that Karasek’s demand-control-support model explains job fatigue, similar to previous research. We found that job fatigue is associated with higher job demands, lower levels of job control and lower levels of job social support. So increasing job demands have a positive, unfavorable effect on job fatigue. However, job control and job social support can be used to reduce job fatigue considering their negative, favorable effect on job fatigue. The amount of variance explained by Karasek’s demand-control-support model was much larger than the amount of variance explained by ambidexterity. We also found a positive interaction effect between ambidexterity and job control. Ambidexterity weakens

the reduction effect of job control on job fatigue, in line with expectations. It implies that the higher the level of ambidexterity, the lower the reduction effect of job control on job fatigue. These findings are relevant for business. Managers who are aware of the necessary project management characteristics that explain variances in job fatigue, can try to manage job fatigue among project workers.

Ambidexterity is still a mere academic construct. The underlying meaning of ambidexterity is explained in a theoretical way and there is no intuitive and substantive meaning which makes that practicing managers rarely use it (Birkinshaw & Gupta, 2013). This PhD dissertation contributed to the understanding and practical relevance of ambidexterity. By explaining all concepts clearly, and clarifying in practice how the ambidexterity capability can be decomposed into different antecedents of ambidexterity that are implemented by a hybrid control package, we made one contribution to bridge the gap between theory and practice.